Marginalized Labor in Colonial Silver Refining:
Reconstructing Power and Identity in Colonial Peru (1600-1800 AD)

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Marginalized Labor in Colonial Silver Refining: Reconstructing Power and Identity in Colonial Peru (1600-1800 AD)

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This dissertation investigates the daily life of indigenous laborers at unregulated, colonial period silver refineries in the Puno Bay of Peru during the 17^{th} and 18^{th} centuries. I directed the Trapiche Archaeology Project to study one of these refineries, Trapiche Itapalluni, at the household level. Using both archaeological and historical data, I argue that rural silver refineries in the Puno Bay functioned as locations of economic opportunity for marginalized populations. Through an analysis of local, unregulated economic activities of the 17^{th} and 18^{th} centuries, I demonstrate how Puno Bay laborers were able to alter their living conditions and take a more active role in the colonial economy. Importantly, these activities occurred over a century before the development of organized trade and labor unions.

My dissertation results indicate that even though architecture and space at Trapiche Itapalluni was restrictive, access to diverse economic resources, local and imported, was accessible for multiple classes of workers. Spatially, Trapiche was less restrictive and controlled than some other refineries in the Puno Bay. Workers also used the same lithic tools and local culinary equipment that they did before the Spanish conquest and consumed a traditional Andean diet of camelid meat, quinoa, and soups and stews. The meat was generally from good quality cuts purchased from a market. However, living and working conditions were unequal at Trapiche. Workers were constantly exposed to toxic levels of lead and mercury. They also slept in small, temporary houses near a loud and dusty mill.

These contradictions reveal the fluidity of daily life within refineries. While unequal and often dangerous, refineries also provided economic opportunities for marginalized peoples, where other such opportunities were limited during this period. Laborers likely made informed, economic choices to enter the silver refining industry for a few months every year, increasing their access to wages and an array of market goods. They may have even brought their families and animals with them, offsetting many of the economic and social risks of this industry.

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Preface

This dissertation research was conducted by the archaeological research project "Proyecto Arqueológico con Excavaciones Trapiche (PAT)," which was authorized by the Peruvian Ministry of Culture with the following permit: RDN 337-2018/DBPA/VMPCIC/MC (2018). Gary Mariscal served as director of the Puno Ministry of Culture during my project and was always willing to lend his support. Karen Durand Cáceres and Jorge Rosas Fernandez were my Peruvian codirectors in 2018, 2019, and 2020 and I owe them a great deal of thanks for their constant support and collaboration. Karen Durand is an especially dear friend, colleague, and lover of bones and she contributed so much to this project.

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I owe a great deal of gratitude to the indigenous communities I worked with in Puno, Peru. To everyone in the communities of Collacachi and Malcomayo, *muchísimas gracias*, *ay suma*, y *yuspajara*. These communities gave us permission to excavate on their land and to share their history with the larger archaeological community. This dissertation would not have been possible without their support. Special thank you to the Arocutipa and Quispe families, including Felipa, Oliver, Ophelia, Milagros, Ruth, and Marcelo. Thank you also to the leaders of these communities, including Jaime Eloy Mamani Mamani, Pedro Bacilio Aroapaz, Dora Salas de Talavera, and Ruprima Arpasi Mamani.

Fieldwork would not have been possible without the extraordinary group of archaeologists and field technicians that joined this project. Javier Chalcha Saraza was my right-hand man for the entire project. His dedication to this dissertation came in many forms. He served as translator, crew chief, illustrator, driver, and pillar of moral support. In moments of crisis, he willed this project into being. I also owe a great deal of thanks to Humberto Ttacca and Amadeo Mamani, who generously shared their many years of altiplano archaeological experience with me. This project would not have been possible without their support, knowledge, and friendship. Further thanks are in order for the local workers on my excavation, including Felipa Arocutipa, Ruth Flores Arocutipa, Ophelia Choque, Luz Flores, Oliver Quispe, Marcelo Quispe, Milagros Quipse, and Luisa Velasquez.

I was also lucky to have many student volunteers on this project, and I cannot thank them enough for their unpaid labor. Student volunteers are the backbone of any dissertation project and mine was no exception. Thank you to Nadia Arzberger, Courtney Besaw, Eduardo Durand Rigamontti, Romario Escalante Segovia, Genaro Escobar Nina, Victor Gonzales Avendaño, Kate Hodge, Jose Nuñez Urviola, Rachael Penfil, Samuel Serrano, Julia Sjodahl, and Any Ruth Villafuerte. You were all wonderful and helped me in so many untold ways, and I am thankful for your friendship as well as your collaboration. I am especially grateful to Victor Gonzales for lending me his years of experience in all matters of Peruvian archaeology, including the Ministerio, AutoCad, frozen excavation units, carrying heavy objects up steep mountains, and teaching me how to make *causa*, *ají de gallina*, and *mayonesa*.

Laboratory analysis would not have been possible without the help of Ophelia Choque and Samuel Serrano. Flotation was performed by Virginia Beatriz Incacoña Huaraya, assisted by Mary Luz Ccalahuille. Field botanical identification was aided by the keen eyes of Katherine Chiou, Alan Farahani, and BrieAnna Langlie. Lithic identification was aided by Jennifer Farquhar, Nathaniel Kitchel, and Arturo Rivera. Initial macro-botanical analysis was conducted by the Laboratorio de Palinología y Paleobotánica at the Universidad Peruana Cayetano Heredia by Fiorella Villanueva. Lizzette Muños Rojas and Verónica Rosales Hilario conducted further analysis of my macro-bots, and Brendan Weaver provided laboratory space for said analysis. Finally, I thank BrieAnna Langlie for her future collaboration on the marco-botanical analysis.

Radiocarbon analysis was conducted at the Penn State Radiocarbon Laboratory in State College, PA. I owe a great deal of thanks to Gina Buckley for processing my samples and facilitating the analysis in a timely manner. Gina also instructed me on how to use OxCal and showed me how to interpret the results, and I owe her a great deal of gratitude.

I also owe many thanks to Sarah Kelloway for conducting the ceramic analysis and pXRF analysis. Sarah was with me at the beginning and end of the 2018 field season, so she was "lucky" enough to experience both kinds of stress unique to the beginning and end of a field project. I cannot thank her enough for her brilliant insights about soil chemistry and colonial pottery forms. I am also indebted to her for my education in Australian slang, risotto, and love of Peruvian deserts. Her collaboration is visible throughout this entire manuscript.

In addition to all the team members on my project, I was helped in many ways by the greater Puno community, including Roger Caraza, Cecilia Chavez Justo, Mario Hurtado Chavez, Edmundo de la Vega, Nicanor Dominguez, and Gary Mariscal. These individuals provided logistical and research support throughout various stages of my project. The Puno community also includes members of the CARI field house, whose members provided me with additional logistical and emotional support. Thank you to Liz Arkush, Ceci Chavez, Edmundo de la Vega, Randy Haas, Nathaniel Kitchel, Liz Klarich, BrieAnna Langlie, Christina Moya, Carol Schultze, Ben Smith, and Ryan Smith. You all helped me in so many ways – thank you from the bottom of my heart. Especially memorable moments of support came when Randy helped me pay for my flotation when I ran out of money, Cristina bought me every flavor of dessert from Ricos Pan on my birthday, and BrieAnna and Humberto saved my life when my combi got stuck in a river. I am also grateful to BrieAnna, Nathaniel, and Randy for our short-lived Puno Running Club, which helped keep me sane on the early days of this project.

Archival research was very important for contextualizing excavation results, and I was able to uncover a variety of helpful documents from the Archivo y Biblioteca Naciones (ABNB) de Bolivia in Sucre, Bolivia, the Archivo General de Puno in Puno, Peru, and the John Carter Brown Library (JCB) and John Hay Library, both at Brown University in Providence, RI. Gabriel René Rivera Bernal was especially helpful in tracking down documents at the ABNB and I am extremely grateful for the ease in which I was able to obtain electronic copies.

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Dedication

This dissertation is dedicated

in loving memory

to J. Kenneth Kennedy

and Janet S. Lauer

1.0 Introduction

1.1 Opening

The legend of the discovery of the Laicacota silver mine near Puno, Peru in 1657 AD is a highly romanticized tale. The hero presented is Joseph de Salcedo (sometimes referred to as José), a Spaniard who traveled to South American in the early 1600s to search for fame, glory, and riches in the Andean silver mines. In the legend, Salcedo discovers the rich Laicacota silver mine hidden under an enchanted lake. The lake had been created by local Andeans to hide their treasure from the Spanish during the original invasion of 1532. The account is as follows:

> It was once, in this very opulent province of silver, especially opulent during the year of 1657, when the mine of Laycacota ("enchanted lake") was discovered. It was called an enchanted lake because it was formed by the ancient Indians in order to hide their wealth. The field master, Don José Salcedo, having heard some vague news of a silver vein at Laycacota, and having been disgusted by his lack of progress at the San José mine, sent his people to work at Laycacota...they drained the lake until the silver vein became clear, and within the lake was an immense amount of white silver, which was removed easily at little cost (Cosme Bueno 1951 [1770]:123; also quoted in Middendorf 1974 [1895]:244. English translation my own).

The romantic style of this retelling is very typical for the 1770s. However, the majority of this account is actually untrue. While Joseph de Salcedo was an actual person and did have bad luck in his mining ventures at the San José mines, he did not actually discover the Laicacota mine. What is missing in the legend, and the majority of accounts from this period, is any active role by local indigenous people, or local knowledge about the existence of the Laicacota mine. In the romanticized version of the tale, Salcedo, as the main protagonist, does all the action.

An even more exaggerated version of the discovery comes less than a decade later, from the German Jesuit Wolfgang Bayer (1776, 1782). In his telling of the legend, Bayer describes an extremely rich silver mine discovered by a Spaniard down on his luck. The mine is revealed to the man by a mysterious native woman. In this version, the man falls ill in the town of Puno and is cared for by a poor, indigenous widow, who offers him her daughter as a marriage partner after nursing him back to health. The girl then goes to Laicacota and reveals the location of the mine:

> *De verliefde Spanjaard geloofde het Indiaansche meisje, merkte de plaats, daar zij gezeten had, naauwkeurig, liet aldaar steenen weggraaven, en vond terstond de rijke zilvermijn. Deeze wees hij terstond den bevelhebber aan, en hem werd vergund, dezelve op zijne eigen kosten te laaten beardeiden. Hij trouwde met de jonge Indiaansche maagd, en begon den arbeid in de mijn met een zo gelukkig gevolg, dat hij in korten tijd een zeer rijk man wierd (Bayer 1782:150-151).*

> The Spaniard, very much in love, believed the Indian girl, accurately marked the spot where she had seated herself, had the stones been dug away there, and immediately found the rich silver mine. He immediately pointed this out to the commander, and he was permitted to operate it at his own cost. He married the young Indian virgin, and started his labor with such fortuitous result, that he soon afterwards became a very rich man (Bayer 1782:150-151. Translated by Lilian Tabois).

A similar idealized tale from the 19th century comes from the Swiss naturalist and explorer Johann Jakob von Tschudi in 1847:

> The Salcedo mine is very celebrated for the vast abundance of its produce, and the tragical end of its original owner. Don Jose Salcedo, a poor Spaniard, who dwelt in Puno, was in love with a young Indian girl, whose mother promised, on condition of his marrying her daughter, that she would show him a rich silver mine. Salcedo fulfilled the condition, obtained possession of the mine, and worked it with great success. The report of his wealth soon roused the envy of the Count de Lemos, then viceroy of Peru, who south to possess himself of the mine. By his generosity and benevolence, Salcedo had become a great favorite with the Indian population, and the viceroy took advantage of this circumstance to accuse him of high treason, on the ground he was exciting the Indians against the Spanish government. Salcedo was arrested, tried, and condemned to death…. the viceroy … ordered Salcedo to be hanged, and set out for Puno to take possession of the mine. But this cruel and unjust proceeding failed in the attainment of its object. As soon as Salcedo's death-doom was pronounced, his mother-in-law, accompanied by a number of relations and friends, repaired to the mine, flooded it with water, destroyed the works, and closed up the entrance so effectually that it was impossible to trace out. (von Tschudi 1847:239-240).

This 1847 retelling now included a moral judgment against Salcedo's enemies, providing divine justice with the eventual flooding of the Laicacota mine. Throughout this version of the tale, Salcedo is depicted as innocent, benevolent, and righteous. He is also depicted as on the side of the local, indigenous population, which was not actually the case (see Domínguez 2006).

Ephraim Squier's late 19th century account is very similar to von Tschudi. Squier writes that an "Indian girl" revealed the mine's location to Salcedo. Salcedo worked the mines until he fell victim to the "avaricious and unscrupulous royal governors" whose triumph over Salcedo was short-lived for "as soon as Salcedo's faithful Indians heard of the proceedings against him, they stopped the drains of the mines and it was filled with water. A small lake now covers the spot" (Squier 1877:356).

These historical narratives about the legend of Laicacota serve as important parables for this dissertation. They show how indigenous actors, especially women, tend to disappear from historical accounts of silver mining and refining in the colonial Andes. Throughout the 18th and 19th century historiography, local Andeans became nameless, passive players. In the case of the Laicacota legend, they are manipulated, and their resources are taken from them. If they are women, they often suffer more, and are exploited through sexual conquest. The only people in these narratives that have any real entrepreneurial action are the Spanish men.

While these narratives are quite common for their time, they hide and obscure the real role that indigenous men and women played in the colonial silver industry in Peru. Andean men and women actively contributed to the discovery and extraction of precious metals from silver mines throughout the 16th – 19th centuries. They, along with enslaved Africans and mixed-race individuals (*mestizos*), played an active and skilled role in silver refining in the southern Andes, especially near the modern city of Puno, Peru, in the western Lake Titicaca Basin. As this dissertation will show, there was much more room for entrepreneurial action by marginalized groups of people in the Puno Bay than the colonial narratives have given credit.

So, what was the true story of the Laicacota silver mine's discovery in the year 1657? It appears the mine was actually owned and operated by an indigenous woman prior to Joseph de Salcedo's appearance in 1657. The name of this original owner is still unknown, as she is only listed in the historical documents as an important indigenous woman, an "*india cacique*" (Galaor et. al 1998:147). We do know that she was powerful enough to own both the Laicacota mine near Puno, as well as other silver mines near the San Antonio de Esquilache mining center, 60 km to the southwest of Puno. She was also godmother to the children of the famous Puno resident and mining entrepreneur, Juan Duran, a Spaniard (Galaor et. al 1998:147). These facts reveal she was likely from a powerful local indigenous family and had made key social allies within the colonial mining industry by the mid-17th century.

It was her important relationship with Juan Duran, however, that eventually led to her loss of property. Sometime in the 1650s, she began to look for someone in Puno to help her work the Laicacota mine, as she was busy overseeing her investments in San Antonio de Esquilache. She contacted Juan Duran for help, and he began to scout for local support in the area (Galaor et. al 1998:147-149). Duran ended up showing the mine to Joseph de Salcedo and asked him to work the mine on behalf of him and the unnamed female owner. Salcedo quickly accepted the proposition and soon found a rich silver vein at the mine (Galaor et. al 1998:147). Instead of working the mine for Duran and his female colleague, however, Salcedo decided to register the rich claim for himself and took sole possession of the Laicacota vein.

This markedly different version of events comes from a Spanish mining report filed in Puno in 1753. Here, Joseph de Salcedo is finally revealed as a bit-player in the real story, essentially stealing the rights to the Laicacota mine from the real hero: a powerful Andean woman and mining entrepreneur. Contrary to legend, the protagonist was actually a very powerful and successful indigenous woman, in charge of multiple silver mines and mining activities throughout the region. This 1753 account reveals that the Laicacota mine was well-known and utilized by locals long before Joseph de Salcedo registered the claim under his name (Dominguez 2006).

I began this dissertation with the parable of the legend of Laicacota's discovery to illustrate an important theme that will run throughout this manuscript. While 18th and 19th century narratives of colonial silver mining in the Andes have somewhat obscured the role of native men and women in the mining and refining industry, my dissertation works to reveal their contributions. I do not claim that indigenous men and women did not suffer under Spanish colonial rule. Nor do I claim that the mining industry was free from exploitative working conditions[1] that exposed laborers to dangerous tunnels, toxic fumes, and heavy metal poisoning (Figure 1.1). However, I do argue that the history of silver refining in the colonial Andes, as well as the daily lives of refinery workers, is much more nuanced, complex, and varied than many colonial and 19th century narratives depict. Marginalized laborers (those without dominant power), including indigenous laborers, women, *mestizos*, and enslaved Africans, were not merely victims of the silver refining industry - they were also active, skilled contributors (e.g., Bigelow 2020; Graubart 2007; Mangan 2005; Velasco Murillo 2013, 2016). This dissertation attempts to illustrate the variety of ways marginalized individuals interacted with the silver refining industry in the colonial Puno Bay of southern Peru.

[1] See Figure 1.1 for an 18th century depiction of the harsh working conditions at the famous silver mine of Potosí in the southern Andes. It depicts indigenous laborers mining ore with pickaxes, carrying ore out of the mine, and the use of llamas in transporting ore to silver refineries located near rivers.

Figure 1.1: Plate 3 from Theodore de Bry's America [1728]. Courtesy of the John Carter Brown Library, Brown University.

1.2 Overview

This dissertation explores how socially marginalized laborers adapted to the Spanish colonization of the silver refining industry in the Andes of South America. Broadly, it examines the conditions that generated unequal conditions for marginal peoples during colonial encounters in the Americas. Specially, it focuses on the social organization, power dynamics, and labor relations between laborers and those in power in the Puno Bay of the western Lake Titicaca region of southern Peru. I use the silver refinery of Trapiche Itapalluni as a case-study in which to investigate daily life and living conditions within this industry. Trapiche, as the site is commonly known, was occupied throughout the 17th and 18th centuries (~1600-1800 AD) and is located in the Puno Bay near the modern city of Puno, Peru (Figure 1.2). Through archaeological survey, excavation, and analysis of material remains from Trapiche, this dissertation examines a range of social and economic signals that were transmitted through laborers' daily tasks within the silver refining industry.

While scholarship from the 1980s and 1990s on colonial silver mining and refining in the Andes tended to examine the industry through the lenses of commercialization, and technology (Bakewell 1984; Cole 1985; Tandeter 1993), the social and cultural implications of living and working in silver mining and refining communities have recently received more attention by historians (Bigelow 2020; Graubart 2007; Mangan 2005). Following these recent trends, this dissertation uses a combination of spatial, archaeological, and soil chemistry analyses to examine daily, household level patterns of inequality, marginalization, and social control at Trapiche. This dissertation contributes to ongoing discussions surrounding the nature of colonial encounters, specifically addressing the lived experience of indigenous laborers within the overarching power structures of the Spanish imperial project (Lightfoot et al. 1998; Rodríguez-Alegría 2005; Silliman 2005; Orser and Funari 2001, Van Buren 1996; Voss 2008a, 2008b, 2008c; Wernke 2013).

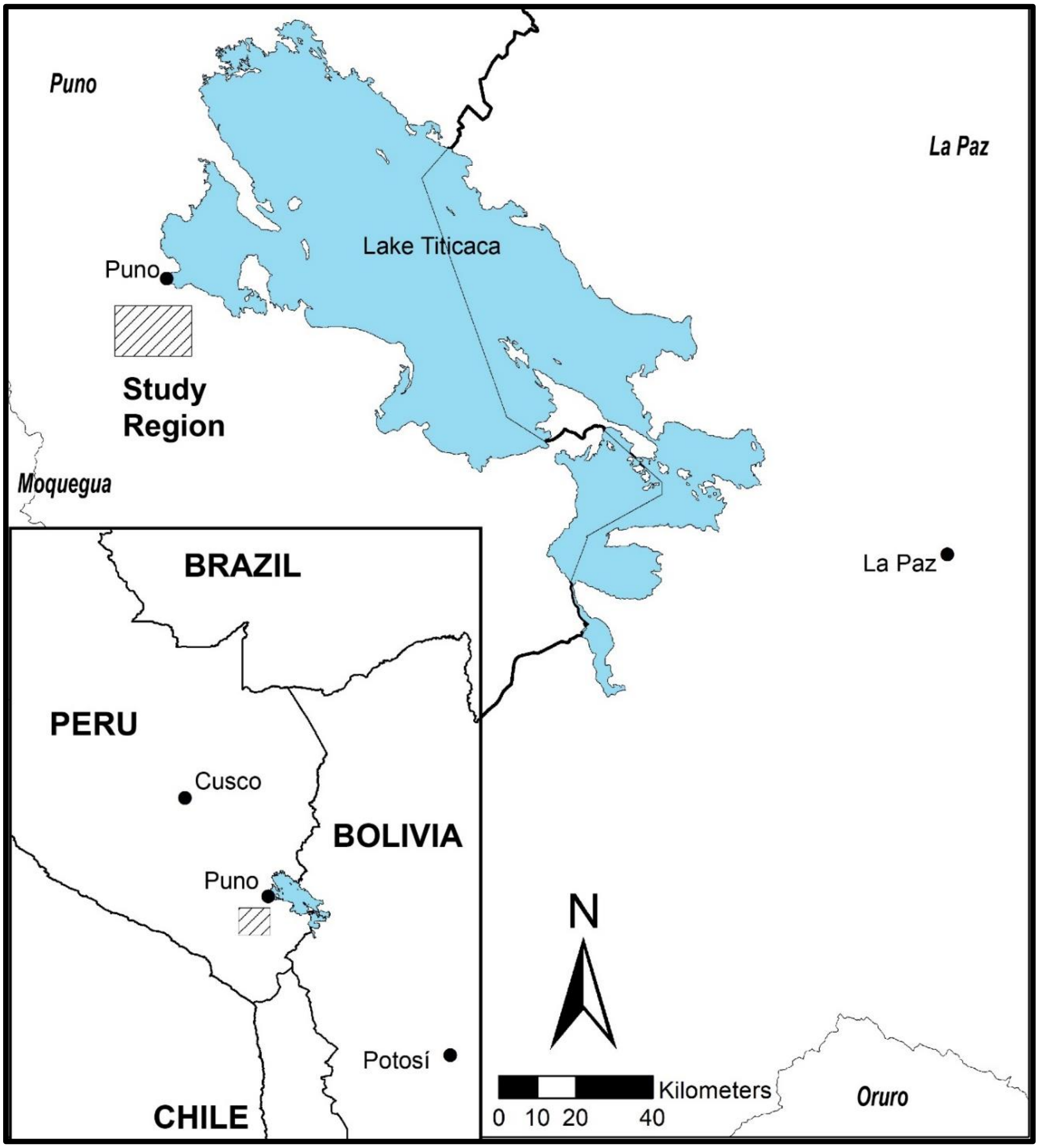


Figure 1.2: Map of study region of this dissertation, south of Puno, Peru in the western Lake Titicaca Basin of Peru.

1.3 Historical Methods and Sources

I wish to make a quick note about my methodology and my use of historical sources in this dissertation. In subsequent chapters, I will detail my methodology for each analysis at the beginning of each chapter (e.g., space syntax methods in Chapter 5, pXRF methods in Chapter 6). However, archival information and historical source material is sprinkled throughout this dissertation, so I wish to use this space here to describe my historical sources and methods before I begin my dissertation in earnest.

Primary source materials come from historical archives in Peru, Bolivia, and the United States. Whenever I cite primary sources in this dissertation, I will provide the archival abbreviation, as well as further information about the folder, page, and/or folio[2] in which the information was found (Figure 1.3). Important references are always included in in-text citations.

In Peru, sources come from the Archivo Regional de Puno (ARP) in the city of Puno. I visited this archive in 2017 and 2018 and draw on primary sources I viewed there, as well as some transcribed texts from these archives that were available to me locally. In Bolivia, I draw on documents from Archivo y Biblioteca Nacionales de Bolivia (ABNB) in Sucre. These were scanned at the archive and sent to me digitally by Gabriel René Rivera Bernal. In the United States, I draw on documents from the John Carter Brown Library (JCB) and the John Hay Library (JHL), both located at Brown University in Providence, RI, as well as documents from the Dumbarton Oaks Library and Collections (DOLC) located in Washington, DC.

[2] For example, see Figure 1.3. It is labeled Folio 1r from the archive ABNB, with reference number MIN 145/8. This would be abbreviated in text as (ABNB MIN 145/8:1r). This document is from the year 1663 and details a denunciation of the Corregidor of the Paucarcolla Province, Luis Cesar Escarzola, for price fixing and personally profiting off the sale of food and wine. There are also details about his mistreatment of laborers.

The majority of the documents I draw on pertain to the western Lake Titicaca Basin and the Puno Bay, where the modern city of Puno is located. Puno sits within the province of Paucarcolla, and many documents I draw on pertain directly to the Paucarcolla province. Often, documents detail specifics from the mining camp located a few kilometers southwest of Puno, known as the mining seat (*asiento de mina*) of San Luis de Alba de Laicacota. This town was often referred to by the shorthand *asiento de Laicacota* or simply *Laicacota.* The spelling of "Laicacota" was not standardized and was sometimes spelled as *Laycacota* or a similar variant. To confuse matters, the name of the silver vein found near Puno on Cerro Negro Peque was also called Laicacota. To avoid misunderstandings, I use the "Laicacota" spelling throughout this dissertation, unless directly quoting from primary sources. I also refer to the physical mine as Laicacota. When I refer to the adjacent mining camp, I use "San Luis de Alba" (Domínguez 2006, 2017).

Whenever possible, I provide a quote with the original language that the text was written in, as well as my English translation. The English translations provided for the primary documents in this dissertation are my own, and subsequently all errors are also my own. At times, my English translations were more free form and often artistic interpretations of the text and were not necessarily literal, word-by-word translations. This is because Spanish (and German and Dutch) from the 17th , 18th, and 19th centuries uses outdated idioms and ways of speaking that might not be readily understandable to modern readers. Whenever possible, I have included the passages in their original language along with my English translations, for readers who prefer to read these quotes in the original. I was aided in my translations by James Almeida, Victor Castillo, Francisco Garcia, Jose Victor Gonzales, and Lilian Tabois.

ABNB: Archivo y Biblioteca Naciones de Bolivia, Sucre, Bolivia

ARP: Archivo Regional de Puno, Puno, Perú

DOLC: Dumbarton Oaks Library and Collections, Washington, DC

JCB: John Carter Brown Library, Brown University, Providence, RI

JHL: John Hay Library, Brown University, Providence, RI

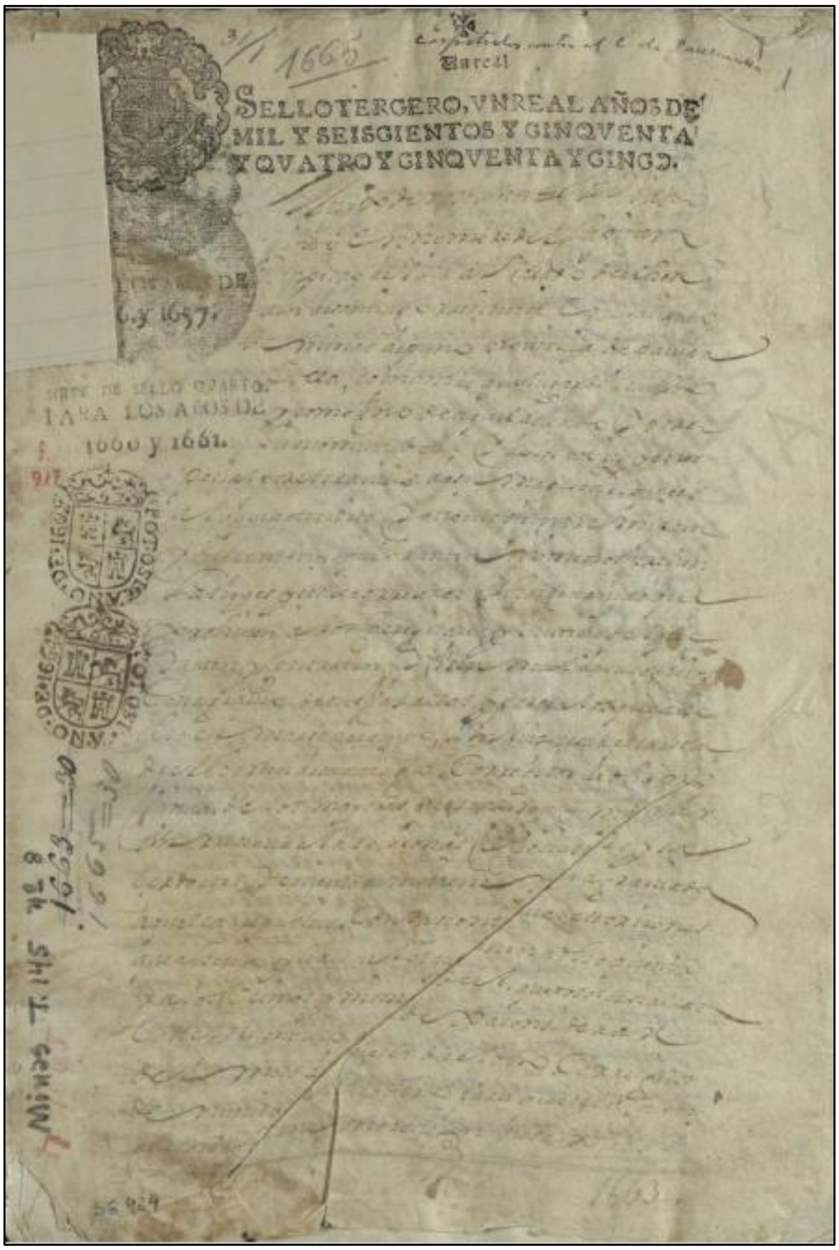


Figure 1.3: Folio 1r, from the archive ABNB, with reference number MIN 145/8.

1.4 The Archaeology of Colonial Encounters

The study of cultural contact and colonialism within the archaeological discipline has long been informed by the European “Age of Discovery” that took place throughout the 15th – 18th centuries (Stein 2005). Traditional scholarship on these well-documented colonial expansions has focused on a top-down depiction of Spanish, Portuguese, and British statecraft, with conquered peoples rarely discussed beyond being cast as passive actors in the acculturation of their traditions. More recent archaeological and historical studies of colonial encounters have taken a bottom-up approach to the processes of colonization, examining indigenous agency (Silliman 2001a), identity formation and maintenance (Loren 2008, Voss 2005, 2008a), and the meaning of space and material culture (Lightfoot 1995; Lightfoot et al. 1998). In these studies, archaeological data has been critical for the documenting the everyday practices of indigenous people living within colonial contexts, complementing the often one-sided and ideologically charged information provided by historical sources (Lyons and Papadopoulos 2002).

One of the challenges archaeologists face is how to address underlying notions that cultural contact was either somehow politically neutral, or that colonialism was inherently a top-down, dominating process (Jordan 2009). In countering many of the domination narratives, archaeologists have emphasized the maintenance and persistence of indigenous cultural traditions (Ferris 2009; Lightfoot et al. 1998, Orser 2004; Panich 2013; Silliman 2009, 2010). Often, this scholarship has shown that indigenous peoples were simultaneously “enabled and constrained by the material and social conditions of life” (Panich 2013:108). As such, different living and working conditions of the past facilitated varying degrees of flexibility for indigenous agency and the maintenance of cultural traditions. This point is especially relevant when we consider highly controlled environments of conscripted and coerced labor, such as the silver mining industry.

Current debates in anthropology have questioned the degree to which individuals within specific cultural, political, and economic fields were able to participate when conditions were unequal. Orser (1990) describes the interplay of domination and resistance between slave plantation overseers and enslaved peoples in the antebellum south. Mining communities in the American West have been viewed similarly, where mine owners asserted social dominance to control labor, although miners had the opportunity to resist by forming labor unions (Hardesty 1998; Paynter and McGuire 1991). In many of these coercive contexts, laborers and enslaved peoples were removed from their social support networks and forced to labor in rural and removed locations, making conditions even more unequal (Marshall 2015; Singleton 1985).

Though often not discussed together, African plantation slavery and coercive labor practices that forced indigenous peoples to perform hard labor in mining operations represent similar, highly controlled colonial settings of "unfreedom" (Reséndez 2016). Coerced indigenous mining labor was the backbone of the Spanish colonial economy, funneling silver from Mexico and Peru to Spain throughout the 16th and 17th centuries (Brading and Cross 1972). Similar to rural slave plantations, these mining communities were removed from society and extremely hierarchical, leaving opportunities for abuses of power and increasingly rigid, unequal ethnic and labor categories related to separate mining, grinding, and amalgamation tasks (Silliman 2001b). Thus, an examination of coercive mining labor provides an opportunity to examine how indigenous individuals created agentive social spaces within highly controlled colonial contexts.

Silver mines and refineries differed from plantations in that the wealth they produced was portable (i.e., silver ore), which could be obtained by laborers in ways that was not possible in a plantation context. However, the work within silver mines and refineries was likely more dangerous than at plantations, as workers were constantly exposed to dangerous underground tunnels, toxic dust and fumes, and heavy metal poisoning.

The silver refinery of Trapiche Itapalluni in the Puno Bay of southern Peru represents an excellent case study to examine inequality and daily life within such a context. Since indigenous laborers did not leave behind written records of their experiences in these refineries, the only way to investigate their lives is through the study of indigenous material culture. This dissertation examines the material remains of daily domestic activities at Trapiche to discuss the living conditions of its laborers. Daily domestic activities include the remains of cuisine, foodways, cooking, storage, and food processing. This includes analysis of animal bones, plant materials, residues, cooking and storage ceramics, use of space, tool use, and middens and fireplace locations.

In examining the social dynamics of one mining community situated in a particular historical, political, and environmental context, this project will explore power relations and the lived experience of coerced laborers writ large. I emphasize the daily practices of Trapiche laborers in this dissertation, and this reorients the "traditional" study of colonial encounters focused on European domination. Instead, I focus on the daily lives and cultural traditions of indigenous peoples that were reproduced, modified, and negotiated through conscious and subconscious activities and actions (Lightfoot et al. 1998, Orser 2004; Pauketat 2001; Silliman 2009, 2010).

1.5 Spanish Colonial Historiography

The emphasis on indigenous daily practice during the "colonial encounter" in Spanish colonial archaeology settings was first brought to light through work by historical archaeologists that first studied identity in Spanish Colonial Florida and the circum-Caribbean (Deagan 1974, 1996, 1998; Landers 1999). Kathleen Deagan's work at St. Augustine, Florida examined the role of acculturation and identity among indigenous and Spanish individuals. Through the process of ethnogenesis, Deagan observed the intermarriage between indigenous and African women and European men as a creolized process that created *mestizaje* – a totally new creole culture (1983, 1996, 1998).

For Deagan, women's work in the household and domestic contexts (through the foods they prepared and the ways in which they prepared them) in colonial settings in Florida and the Caribbean were the principal ways women helped create a new creolized culture. While some scholars challenge the "St. Augustine Pattern" for its generalized explanation encompassing all Spanish American colonial contexts, as well as its dualistic categories in artifact analysis and interpretation (Voss 2008a), Deagan's household approach to identity studies in imperial contexts had a major impact on subsequent studies, precipitating a new generation of research focused on the daily life of colonization.

These new colonial period archaeology studies, beginning in the early 2000s, have focused on the variabilities of identity, race, labor, power, status, and lived realities of colonial individuals in a wide variety of colonial contexts (Dietler 2005, 2007; Ewen 2000; Jaimeson 2005; Lenik 2012; Loren 2000, 2008, 2017; Panich 2013; Panich et al. 2014; Silliman 2009, 2010; Stein 2005; VanValkenburgh 2012, 2017; Voss 2005; Voss 2008a, 2008b, 2008c; Wernke 2013).

In the Andes specifically, historians and archaeologists have examined race, labor, and status in the colonial period through clothing choices (Presta 2010; Walker 2017), food choices (Jamieson and Sayre 2010), ceramics (Kelloway et al. 2018, 2019; VanValkenburgh et al. 2015; 2017), religious practices (Norman 2019), legal mobilization (McKinley 2016; O'Toole 2012), social hierarchies (de la Cadena 2000, 2005; Dueñas 2017; Jamieson 2005), and landscape control (Wernke 2010, 2012).

These recent trends in Andean colonial archaeology owe much to trends in the historical scholarship occurring in the Andes over the last few decades. Of these studies, the work by historian Steve Stern in the 1980s and 1990s is particularly important to my dissertation research. Stern's work was one of the first to move Andean historical scholarship beyond the broad societal analysis of the Colonial Andes, where common laborers were often viewed as "reactors to external forces" with little power and control over their daily lives (Stern 1987:5). To push back against this narrative, Stern chose to focus on indigenous people as active actors, highlighting their own initiatives and experiences (Stern 1987). Stern's approach is apparent in more recent historical studies in the Andes, and one I also take in this dissertation (Earle 2012; Larson 2004; MacCormack 1991; Mangan 2005, 2016; Mills 1997; O'Toole 2012; Premo 2000; Rappaport and Cummins 2012; Scott 2009; Silverblatt 2004).

1.6 The Archaeology of the Human Experience

Stern's focus on indigenous experiences during the colonial period in the Andes could easily be filed under the relatively new approach to the archaeology of daily life, termed the "Archaeology of the Human Experience" (AHE) (Hegmon 2016). This approach focuses on what people *experienced* in the past – i.e., what their living and working conditions were like, how their labor was organized, and how these conditions are both *part of* the wider social context and can *change and affect* the wider social context. Often this approach focuses on the lives of everyday people in the past, and looks at topics such as well-being, health, inequality, urbanism, conflict, collapse, and social identity (Hegmon 2016).

In some AHE approaches, archaeologists rely on modern measures of quality of life and health put forth by the United Nations, such as their seven measures of human security (Hegmon 2016; Hegmon et al. 2014). These include things like economic security, food security, health security, and environmental security, as well as more nuanced qualities such as community security (secured membership within a group) and political security (freedom from restricted movement, forced labor, and captivity).

A similar approach to studying well-being in archaeology has recently used philosopher and economist Amartya Sen's "capability approach" to examine inequality in the past (Nussbaum and Sen 1993; Sen 1989, 1999). Arponen et al. (2016) posit that this approach, which focuses on measuring human well-being through functional capabilities (what someone is *able* to be, or *able* to do) is a better measure of inequality and well-being than traditional market-based economic measures of material resources (wealth, income, assets, material possessions, etc.). An important part of the capability approach is its emphasis on the multi-dimensional nature of welfare, as well as the heterogeneity of what it means to "live well."

Within the capability approach, well-being is measured in terms of an individual's capability to function. Put another way, well-being constitutes an individual's "effective opportunities to undertake the actions and activities they want to engage in, and be whom they want to be" (Robeyns 2005:95). These beings and doings are termed "functionings" by Sen, and include "working, resting, being literate, being healthy, being part of a community, [and] being respected" (Robeyns 2005:95). There is a distinction here between an individual's *achieved functionings* (what they are actually able to do) and their *capabilities* (their freedom or opportunity to have a choice, even if they do not take it) (Robeyns 2005). In this approach, the opportunity to do something is just as important as the actual doing.

The capability approach can also measure the ways in which individuals have been deprived of necessary or "critical" capabilities, through such things as ignorance, government oppression, distance, and lack of financial resources. For Sen, these "basic capabilities" refer to the freedom to do basic acts of survival (such as accessing food or shelter), which allow them to avoid poverty (Sen 1987:109). While basic capabilities are integral to studying well-being of individuals, the fulfillment of these capabilities does not negate the presence of inequality in affluent communities (Robeyns 2005:101).

Sen's approach to well-being has sometimes been criticized as being too broad, especially as he does not endorse a particular list of important or critical capabilities. Following Sen's initial ideas, Nussbaum has proposed a list of what she determines are the ten most important categories of human capabilities: 1). life; 2) bodily health; 3) bodily integrity; 4) senses, imagination, and thought; 5) emotions; 6) practical reason; 7) affiliation; 8) other species; 9) play; and 10) control over one's environment (Nussbaum 2000, 2003). While this list is very much rooted in modern perceptions of society, it provides a more concrete way to apply the capability approach in the archaeological record.

Another new conceptual framework related to well-being and experience in the archaeological record considers measures of prosperity, prestige, and quality of life (QOL), put forward recently by Michael E. Smith (2019). Smith looks at QOL at the household level by measuring indicators of wealth, while looking at prosperity on a larger, community level. Smith's discussion of prestige borrows from Sen's capability approach, looking at peoples' "capabilities" and inter-community connections. When examining QOL at the household level, Smith examines material indicators of wealth (house size, type of goods, quantity of goods) as well as the "capabilities" of people within the households, such as their diversity of possessions and external social networks (exchange systems or style networks) (Smith 2019:489).

In this dissertation, I take a combined approach of AHE, capabilities, and QOL to study the lived human experiences of laborers working and living in the Trapiche Itapalluni silver refinery. Because I focus my analysis at the household level, I draw on Smith's (2019) measures of QOL, including size of household, durability of building materials, amount of material goods, and type of material goods. I also am very interested in examining human capabilities, or the ways that people *experienced* the past (Hegmon 2016). I focus on Hegmon's economic security, food security, health security, environmental security, and political security (or, for Nussbaum, the human capabilities of life, bodily integrity, bodily health, and control over one's environment). Many of these measures are based on analysis of archaeological correlates of food and diet, as well as provisioning. Additionally, the organization of space at Trapiche relates directly to bodily health and control over one's environment, as I examine control, surveillance, restriction, and exposure to toxic materials at the refinery. The study of food, food security, and health is also very integral to this dissertation, and much archaeological research has already been done to link culinary traditions to key social and economic conditions of daily life in the past.

1.7 Practice, Foodways, and Inequality

The remains of culinary traditions and consumption practices are key correlates for documenting everyday actions and human experiences associated with power, status, and inequality (Appadurai 1981; Dietler 1990, 2001; Hastorf and Weismantel 2007). Recent archaeological scholarship of foodways has expanded upon more functionalist approaches of subsistence and procurement to consider the range of social, political, and symbolic powers of food in the past (Hastorf 1991, Twiss 2007; Voss 2008a). Emphasis has turned toward agency, practice, and social reproduction, stressing the social symbolism of everyday food practices such as the preparing, serving, and consuming of meals (Atalay and Hastorf 2006). It is in these habitual foodways practices that social structures emerge and solidify (Bourdieu 1990; Dietler 2007).

When foodways are studied through the lens of *gastropolitics* (Appadurai 1981), culinary events become especially charged and can indicate the construction of social relations characterized by power, rank, and gender (Appadurai 1981:496). In the colonial Andes, the reconfiguration of social and political hierarchies following Spanish conquest led to a range of foodways negotiations (Silverblatt 2004). DeFrance (2003) used the high frequency of caprine and chicken remains at the 17th century elite Spanish residence of Tarapaya outside of Potosí (Bolivia) to argue that elite Spaniards were able to overcome challenges of elevation and distance to import foreign, ethnically Iberian foods for their diet. In contrast, Jamieson and Sayre (2010) have shown that Eurasian barley was actively adopted by poor, indigenous commoners in Riobamba (Ecuador) during the 18th century, challenging the assumption that all European foodstuffs were only used by higher-status Spaniards.

In cases where indigenous domestic practices persisted relatively unchanged throughout the early colonial period (deFrance 1996; deFrance et al. 2016), the preexisting labor practices, trade and exchange systems, and geographic locations of the colonial settlements were key. For example, high-altitude camelid herding practices were not disrupted at the early colonial *doctrina* settlement of Malata, although an increase in tools related to weaving suggest an increase in the production of camelid fiber and cloth for Spanish-requested tribute goods (deFrance et al.

2016:315). In the extremely inhospitable locations of colonial mining sites like Potosí and Porco (Bolivia), residents had to import most of their food products, and early on during the colonial period, indigenous laborers relied heavily on provisions sent to Potosí from their home communities (Cobb 1949).

1.8 Archaeology of Marginalized Labor in Mining

Mining is a central economic activity in many complex societies (Godoy 1985) and has been a critical driver of the Peruvian economy since the early colonial period (1550-1700 AD). As such, it presents a perfect case-study in which to examine the daily experiences of laborers working in this industry. During colonial period, Peru's mineral wealth was used to fund the Spanish Empire's geopolitical domination at the expense of indigenous Peruvians (Brown 2001). Many Andeans were forced to labor in distant mines and refineries, decimating local communities.

Recent archaeological scholarship has called deserved attention to the social realities of miners across the globe (Knapp, Pigott, and Herbert 1998). Scholars have examined the role of immigrant workers in historic mining camps across the American West (Fosha and Leatherman 2008; Hardesty 2010) and investigated how class and ethnicity structured settlement layout in Australian mining settlements (Bell 1998). Mining camps have also been shown to be contexts of extreme hierarchy and exploitation (McGuire and Reckner 2002; Nash 1993). The specialized nature of labor tasks in this industry (mining, grinding, amalgamation, refining), as well as their routinized and habitual nature, created very distinct social experiences for different categories of workers and administrators in the past (Silliman 2001b).

Because many mining camps and refineries were temporary and isolated, they provide a unique context in which to observe the negotiation of social relationships in contexts of uneven power. For example, did the removed nature of silver refineries create an environment of increased abuse and mistreatment of indigenous laborers? Or were living and working conditions more equal? While historic mining camps exhibited frequent economic and political conflict between laborers and owners (Hardesty 1998; Paynter and McGuire 1991), they were also characterized by communal social relationships and solidarity, with a shared history of work and living revolved around the extraction of a single commodity (Bulmer 1975; Killick 1998). In this regard, mining communities on the colonial frontier of Peru offer exciting potential to increase our understanding of power and its relationship to daily social practices.

1.8.1 **Peripheral Mines and Refineries in the Andes**

Scholarly work on colonial silver mining in the Andes has traditionally focused in the regions of Potosí and Huancavelica. Potosí, the location of the largest and richest silver mine in the Americas, has been extensively documented in primary (Agricola 1950 [1556]; Ocaña 1608 [1969]) and secondary literature (Bakewell 1984; Cole 1985; Tandeter 1993). Scholars have documented the long-term effects of the compulsory Potosí labor draft (the *mita*) on the disintegration of local communities in the southern Andes through exposure to dangerous health risks and outward migration. Additionally, scholars have examined indigenous labor at the Huancavelica mercury mine in the central Andes, focusing on harsh working conditions (Brown 2001; Robins 2011).

While deserved attention has been placed on living and working conditions of these important mining centers, historical sources indicate that equal numbers of laborers were forced to work in more removed silver refineries, which were ubiquitous on the colonial landscape (Cole 1985). There, mined ore was taken to be crushed and combined with mercury to produce highly refined silver. Following the introduction of patio amalgamation in 1571, refineries rapidly appeared alongside rivers, using human and waterpower to pulverize and amalgamate large batches of ore (Bakewell 1984). Depictions of Potosí refineries describe large patios with central water-powered wheels that lifted stamp-heads for ore crushing (Agricola 1950 [1556]; Ocaña 1969 [1608]). Laborers were assigned to manage the stamp-heads, as well as to sort, clean, and carry the processed ore to amalgamation pits. Most often hard labor was done by *mitayos* (conscripted indigenous laborers), while *mingas* (paid laborers) and other skilled workers were employed in the amalgamation processes (Cole 1985). The work was supervised by overseers hired by enterprising Spanish refinery owners.

The study of living conditions and daily life inside these silver refineries is particularly interesting because refineries were removed from colonial society due to their location outside of towns and communities. They had to be located near waterways and were worked by a subset of the colonial population, including coerced indigenous laborers and enslaved Africans. The owners and overseers of many small-scale refineries were also arguably "marginal," as they were often lower-status and lived on the fringes of colonial society (see Chapter 2 for more detailed descriptions of owners and laborers).

The removed environment of the refineries likely produced a new social world for the various, marginalized colonial individuals to inhabit. Because these locations were disconnected from the rest of colonial society, they may have been locations where laborers could gain more agency and control over their lives than may have been impossible in everyday, urban society. Refineries may have been locations where the rules and norms of Spanish colonial society did not apply or were possibly reinvented. Especially because most of the inhabitants of these refineries were likely from lower rungs of colonial society, there was likely new types of interactions and norms that developed throughout the occupation of these sites throughout the colonial period.

1.9 Research Questions

This project broadly examines how marginalized laborers adapted to the Spanish colonization of the silver refining industry in the colonial Andes of South America. In my research, I investigate social organization, power dynamics, and labor relations in the Puno Bay of the western Lake Titicaca region. In this dissertation, I use multiple data sets to assess the following broad research questions:

1) **What was the colonial silver refining industry like in the Puno Bay?**
2) **What was daily life like for refinery laborers in the Puno Bay?**
3) **How did silver refining opportunities change over time in the Puno Bay?**

Through a series of pedestrian surveys, geochemical soil surveys, archaeological excavation, and artifact analysis, my dissertation assesses and answers these questions. I collected data at various levels, including regional data, data from multiple sites, and fine-grained data from vertical excavations at a specific case-study site: Trapiche Itapalluni. The methods and results of each of these stages of research are presented in the following chapters of this dissertation.

1.10 Outline of Dissertation

My research questions are addressed throughout this dissertation, examining labor, inequality, and daily life of laborers within the site of Trapiche Itapalluni, in the Puno Bay of southern Peru. In **Chapter 2**, I examine the development of colonial silver refining in the Andes. I detail how silver mining and refining has been traditionally studied, with a focus on technological depiction of labor. Drawing on my own archival research, I build on these studies by focusing on social realities attached to these labor roles. I argue for a more nuanced view of silver refining in the Andes; one with agentive spaces that provided (some) space for (some) people to improve economically throughout the 17th and 18th centuries. My research reveals how, as silver refining became more complex, laborers were able to employ their sought-after skills to enter and exit the silver economy seasonally, providing them with additional income during a period when little was available outside of the traditional agropastoral economy of the Andes.

Chapter 3 details the environmental setting and historical context of the Puno Bay region, located in the western Lake Titicaca Basin of southern Peru. This includes the geological, social, and political context of the Puno Bay from the 15th – 19th centuries, although I focus most of this chapter on the middle colonial period of the 17th and 18th centuries. I provide an overview of early colonial mining in the region, highlighting silver mining at San Antonio de Esquilache before detailing the origins of the silver mines at Laicacota and Cancharani in the Puno Bay, as well as the early settlement and development of the city of Puno and the mining camp of San Luis de Alba. I touch on various conflicts throughout the 17th and 18th centuries (such as the Laicacota Conflict/Rebellion) and trace silver mining and refining into the 19th century in the region.

Throughout this chapter, I show how the control of the silver mining industry in Puno changed over time. While the early years of colonial mining saw the control of mines and technology by only a few individuals, later periods showed more diffused mine ownership through the formation of companies that allowed more people to be directly involved in operations. The ethnicity and identity of laborers at these mines also shifted through time, as did their statuses as free, forced, and enslaved laborers.

In **Chapter 4**, I synthesize archival and survey data I have collected on the silver refineries of the Puno Bay to provide a spatial history of silver refining throughout my study location. I present the results of my archaeological survey that I conducted in 2017, where I identified eight silver refineries near Puno. I then use primary documents from a range of archives to identify the names and owners of these refineries. My results reveal how the ownership and control of Puno Bay silver refineries changed during the 17th and 18th centuries, becoming less integrated. During this time, total control of the production chain by one or two powerful individuals broke down and became less integrated by the mid-18th century.

Chapter 5 presents the results of my space syntax analysis at three silver refineries in the Puno Bay: Trapiche Itapalluni, Chorrillos, and Santo Cristo. I begin the chapter with a discussion of the space syntax methodology, and then analyze control, integration, and site depth at each of the three refineries. This analysis reveals the varying degree of control and integration within Puno Bay refineries, likely due to their use and ownership over time. For example, the site of Chorrillos was likely an important and highly controlled *ingenio* stamp mill, located close to the Cancharani and Laicacota mines. In contrast, Trapiche's spatial layout was much less regulated, controlled, and integrated than Chorrillos, likely due to its more marginal nature as a small, *trapiche* grist mill.

In **Chapter 6**, I present the results of my portable X-Ray fluorescence spectroscopy (pXRF) survey, which identified and confirmed the use of mercury and the patio process in silver refining in the Puno Bay as early as the mid-17th century. I begin the chapter with a discussion of the pXRF survey methodology, and then detail my results, which identified highly toxic levels of mercury and lead in surface soils at the Trapiche Itapalluni refinery. I detail my mitigation efforts, in line with the Environmental Protection Agency (EPA), and I also highlight the scientific importance of identifying metallurgical zones of silver refining *without* having to excavate in potentially toxic soils. My results found evidence for the use of the patio process with mercury amalgamation at Trapiche, as well as local Andean developments to the refining process.

Chapter 7 details the 2018 excavations at Trapiche Itapalluni. I begin the chapter with a discussion of my excavation methodology, and I include information on the location of excavation units, as well as a discussion of the presence of features. I include a summary of site chronology and site stratification, which I support with a discussion of site architecture and building materials. I break site occupation into four different phases, Phase A, B, C, and D, and all phases sit within the 16th- 18th century time period. My results indicate there were unequal living and working areas at the site, used by different categories of workers.

Chapter 8 describes the results of my artifact analysis of materials recovered during 2018 excavations at Trapiche. Analysis took place throughout 2018 and 2019. I begin this chapter with a discussion of my artifact analysis methods and procedures, and I detail my methods for each artifact category I analyzed. At the beginning of this chapter, I present the results of my analysis of surface materials, faunal remains, macro-botanical remains, micro-artifacts, lithics, metals, and ceramics. I provide short interpretations of my results but leave further site-wide discussions of data patterns for Chapter 9. At the end of this chapter, I present a summary of the artifact chronology at Trapiche, using ceramics, coins, and beads, as well as radiocarbon dating. Results reveal there were clear higher-status and lower-status residential areas at Trapiche, which correlated with different diets and material culture. Results also reveal the presence of women living at Trapiche, including a possible domestic servant and/or concubine/wife.

Chapter 9 presents my discussion and interpretation of data collected in my dissertation. It combines multiple datasets from my dissertation project, including data from drone mapping, pXRF soil survey, architectural survey, excavation, and artifact analysis. I present an intra-site analysis of space, control, provisioning, and daily life within the Trapiche refinery, using a suit of multi-variate statistical analyses.

I conclude this dissertation in **Chapter 10**. Here, I summarize my research questions using the data and results presented in Chapters 2-9 of this dissertation. I also use this chapter to place the site of the Trapiche Itapalluni refinery into its larger colonial context, comparing the patterns that I have observed here with other areas of silver production in the colonial Andes. This includes comparison with San Antonio de Nuevo Mundo, a peripheral mining site, as well as with Porco, a major, centralized mining site near the urban center of Potosí. I end with a discussion of daily life, well-being, and quality of life within Puno Bay refineries, and I situate my dissertation within the broader body of research that looks to examine marginalized labor in unequal, unfair, and exploitative colonial and postcolonial contexts.

2.0 The Modernization of Silver Refining

2.1 Introduction

Chapter 2 situates this dissertation within the broader historical context of silver refining in the Viceroyalty of Peru during the 16th – 18th centuries. While mining and mine labor will be discussed, silver refining will be emphasized, concentrating on what happened to the silver ore *after* its initial extraction from the mines, during the silver refining process. The chapter loosely follows the technological development of silver refining in the Andes, specifically the introduction of the patio process and mercury amalgamation and tracks the social trajectory of this industry.

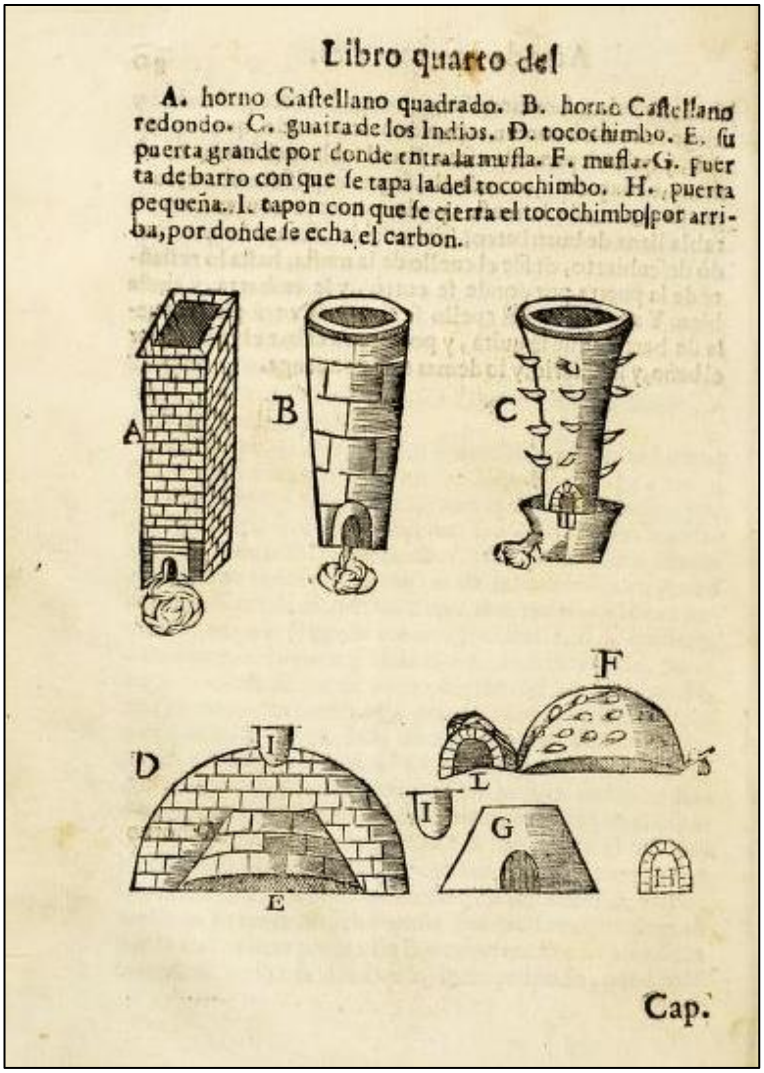
In addition to discussing silver refining technology, this chapter attempts to present a more nuanced interpretation of silver refining, as well as the various experiences of daily life within silver refineries. The chapter ends with a discussion of the various opportunities some silver refineries may have provided labors in the Andes, which was especially true for 18th century Puno.

2.2 Prehispanic Andean Silver Mining

To understand the development of the colonial silver mining and refining industries in the Andes, it is important to examine the prehispanic silver industry that it was built and modeled upon. Prior scholarship on native Andean silver mining has tended to focus on understanding the technological aspects of indigenous production. Historians and archaeologists have highlighted the use of *huayrachinas*[3], or wind furnaces, as important indigenous technological inventions that were used to smelt silver and copper (Figure 2.1) (Bakewell 1984; Van Buren and Cohen 2020; Van Buren and Mills 2005; Van Buren and Weaver 2012). These furnaces, which were often built on the top of windy hills, used the natural flow of air, rather than bellows or blow pipes, to provide oxygen to the charge (Van Buren and Mills 2005:5). Many early Spanish chroniclers document their use, describing them as cylindrical clay or stone towers one meter in height, with holes that allowed the wind to pass through (Van Buren and Cohen 2010:31). *Huayrachinas* were used to heat either silver chloride ore (mixed with a lead sulfide) or argentiferous galena (PbS with Ag). Upon heating the ore, the lead and silver combined.

The lead/silver bullion that was produced in the *huayrachina* was further refined in a *tocochimbo*, a small cupellation hearth used with a blow pipe to remove the lead and leave pure silver (again, see Figure 2.1) (Van Buren and Mills 2005). Early Spanish chroniclers described *tocochimbos* as located within native homes, under the control of specialized laborers (Van Buren and Mills 2005). In some instances, archaeologists have found evidence for the continuation of these prehispanic smelting practices throughout the 18th - 20th centuries (Smit 2018; Van Buren 2021; Van Buren and Mills 2005: Van Buren and Weaver 2012).

[3] Often, Andean historians will refer to these furnaces as *huayras* or *guaryas*, while Andean archaeologists tend to use the term *huayrachina*. Both terms are synonyms and can be used interchangeably. I use *huayrachina* in this dissertation.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A. horno Caſtellano quadrado. B. horno Caſtellano redondo. C. guaira de los Indios. D. tocochimbo. E. ſu puerta grande por donde entra la mufla. F. mufla. G. puerta de barro con que ſe tapa la del tocochimbo. H. puerta pequeña. I. tapon con que ſe cierra el tocochimbo por arriba, por donde ſe echa el carbon.

Cap.

Figure 2.1: Indigenous metallurgical technology, including a huayrachina (C) and a tocochimbo D). Barba 1640:80v.

Indigenous silver refining technology is often compared to subsequent colonial period developments that took hold in the Andes in the 16th and 17th centuries. Scholars note that the scale of production with *huayrachina* and *tocochimbo* technology was small and these furnaces and hearths could not be increased in size without losing their functionality (Van Buren and Cohen 2010). In contrast, newly introduced European reverberatory furnaces were able to accommodate large quantities of ore, although they also required large amounts of costly fuel. European technologies slowly replaced indigenous technologies throughout the colonial period. Although, as I will discuss below, Andean refining specialists also actively altered European technology to fit their local contexts, considering the composition of local ores, as well as the Andean high-altitude climate and marginal weather patterns (see Chapter 6, also Bigelow 2020; Guerrero 2016).

In the early colonial period, prior to the mid-16th century, indigenous smelters continued to control the means of silver production in the Andes. At Potosí, indigenous *yanakuna* (refining specialists) maintained control of silver production from the 1540s until the early 1570s (Van Buren and Cohen 2010; Van Buren and Presta 2010). During the first few decades after Spanish contact, silver was mined by *encomienda* indigenous laborers, often called *indios varas* (Indians by the yard), a reference to how many yards a laborer could work on a specific silver vein (Lane 2015). The mined ore was then refined by the *yanakuna* specialists in the indigenous *huayrachinas* and *tocochimbos* (Bakewell 1984).

While a tax, tribute, or portion of the processed silver was paid to Spanish *encomenderos* (Spanish policy holders that were provided with indigenous labor), indigenous miners and refiners kept the majority of their earnings and continued to control the system of production. Many grew rich during this period (Lane 2015). By the end of the 1560s, however, production fell dramatically at Potosí as the easily smelted silver chloride ores from superficial and weathered deposits were mined out. This left behind the harder-to-process *negrillos,* deeper silver sulfide ores, as well as tailings (left over materials) unable to be processed by *huayrachinas* due to their complex makeup of iron, sulfur, and other ores (Guerrero 2017:53).

As European refining technology slowly replaced Andean smelting technology following the 1570s, indigenous metallurgists throughout the Andes creatively combined indigenous silver refining technology with European technology. At Porco, Bolivia, archaeologists found that *huayrachinas* co-existed with a variety of open hearths, including European reverberatory furnaces, throughout the colonial period. This suggests that indigenous workers fused their native technologies with European ones (Van Buren and Cohen 2010; Van Buren and Mills 2005). In Chapter 6 of this dissertation, I present results from my own study at 17th and 18th century silver refineries in the Puno Bay, which reveal how local silver refiners adapted European refining technology to the marginal environment of the western Lake Titicaca Basin through the addition of added heat and roasting techniques.

While prehispanic mining technology differed from European-introduced methods, the need for labor was equally important, both pre- and post-Spanish contact. Precious metals, such as copper, silver, and gold, were very important to prehispanic empires in the Andes, such as the Inka, who used metals as important prestige goods in their political economy during the 14th and 15th centuries (D'Altroy and Earle 1985; D'Altroy 2015). The Inka required large numbers of workers to mine and smelt these important state goods, and exploited hundreds of mines throughout the Andes (Garrido and Salazar 2017). To supply enough labor for these mining initiatives, the Inka relied on the *mit'a* (labor tax), where men of a certain age were drafted for state-sponsored labor service, receiving food and drink as reciprocity for their efforts (D'Altroy 2015; Julien 2012).

Many *mit'a* laborers were resettled far from their home communities to work in provincial ore-rich areas, mining and smelting ore for the Inka state (Van Buren and Presta 2010). These large laborer resettlement projects included various forms of coercive labor arrangements, including *mitayos* (*mit'a* laborers), *yanakuna* (hereditary servants), and *mitmaqkuna* (resettled laborers) (Costin 2004, 2018; Rostorowski 2008). *Mitayos* under the Inka Empire were conscripted laborers from the rotational *mit'a* labor draft, while *yanakuna* were hereditary servants or retainers who were often skilled in specific professions, such as using *huayrachinas* to refine silver (Bakewell 1984). *Mitmaqkuna* were large groups of people forcibly moved by the Inka for a specific work-related objective, such as mining ore in distant provinces (Berthelot 1986).

Most Inka mining efforts took place in the southern Collasuyu region of their empire, which included the Puno Bay, as well as large portions of southern Peru, Bolivia, Argentina, and Chile (Garrido and Salazar 2017). At Porco, Bolivia, archaeologists found that both non-local *mitmaqkuna* and local *mitayo* laborers took part in basic mine labor, such as working in the silver mines and moving the ore to smelting locations. The more specialized activities, such as smelting the ore in the *huayrachinas* and *tocochimbos*, was done by nonlocal specialists, likely *yanakuna* (Van Buren and Presta 2010). Van Buren and Presta suggest that seasonal *yanakuna* smelters, as well as experienced local *mitayos*, were trusted to smelt and refine silver for the Inka Empire at Porco (Van Buren and Presta 2010:190). Historians support this argument, documenting *yanakuna* working as specialized refiners in Potosí and Porco by the mid-16th century (Bakewell 1984).

Present-day Chile was also an area of Inka-centered metallurgical production during the last century of Inka rule and included sites like Collahuasi, El Abra, Cerro Verde, and *Viña del Cerro* (Garrido and Salazar 2017; Raffino 1982). At the copper mine of San Jose del Abra, archaeologists have found the remains of two Inka labor camps. In addition to the mine and camps, they located mineral crushing areas, storage structures, llama corrals for caravans, domestic buildings, administrative building, and ritual platforms (Núñez 1999; Salazar 2008; Salazar and Salinas 2008; Salazar, Borie, and Oñate 2013:257). The mining camps that housed the laborers were segregated and controlled, and included worker dormitories, domestic hearths, and standardized food remains provisioned by the Inka state (Salazar, Borie, and Oñate 2013). Archaeologists do not believe that the laborers at El Abra were resettled *mitmaqkuna*. Instead, they argue the workers were local Atacamenian copper-mining specialists who served the Inka through reciprocal tribute and *mit'a* requirements.

While archaeologists have learned much about prehispanic mining practices in the Andes, especially in the southern Andes, there is still much that is unknown about the social ramifications of mining, refining, forced labor, and resettlement throughout the Late Horizon period. Even less is known about the daily lives of the silver miners and refineries themselves. The question remains whether the miners and refiners were forced into their labor, whether it was a more comfortable form of specialized employment, or whether it was a mix of these conditions depending on the context. According to indigenous miners in 1559 AD, the Inka Empire even recruited couples to their mining centers, rather than drafting single men, in an apparent attempt to make Inka state mining more family-accessible (Berthelot 1986:74).

Yanakuna in the Inka Empire were a special type of laborer category and were often used for silver smelting, which eventually became silver refining. These were people who had been forcibly removed from their native social networks and became hereditary servants, with their products wholly controlled by their lords and masters. *Yanakuna* have sometimes been described as a *prestigious* labor class in relation to silver refining, often due to their skilled craft and attachment to royal Inka estates which provided them with prestige goods and social benefits

(Cieza de León 1959 [1548]; Cobo 1983 [1653]; Sarmiento de Gamboa 2007 [1572]). However, recent scholars have argued for a more nuanced understanding, categorizing *yanakuna* as a type of "unfree" labor in the Inka Empire. Hu and Quave (2020) have argued that *yanakuna* prestige did not always equate to power, autonomy, and/or wealth, and that we should rethink our old assumptions about Inka imperial practices (Hu and Quave 2020).

Further work is needed at Inka mining sites in the Andes, as well as mining sites with transhistorical contexts, to better understand labor, inequality, and social life of miners throughout the 14^{th} - 16^{th} centuries. What *is* clear is that prehispanic mining during the Inka Empire relied on a range of "unfree" labor strategies to mine, smelt, and transport ore throughout the Andes. As we will see in subsequent sections of this dissertation, the Spanish Empire took advantage of these existing labor systems and used and adapted them during their own quest for mineral extraction.

2.3 Colonial Mining in the Andes

As was outlined in the previous section, indigenous Andean mining technology was adapted, combined, and replaced by European technology in the colonial period. Prehispanic labor practices related to the mining industry were also adapted and altered. The Inka *mit'a* (reciprocal, temporary labor service) was altered in the 1570s by Viceroy Francisco de Toledo and it became known as the colonial *mita* labor draft (Bakewell 1984; Cole 1985). This colonial *mita* was a forced labor draft of indigenous, adult men in the Andes specifically aimed to reinvigorate the silver mining industry that had collapsed after the early Potosí bust of the 1560s (Toledo later established a *mita* draft at the Huancavelica mercury mine as well).

While the colonial forced-labor draft was supposed to be rotational, that was never truly the case and the *mita* ended up decimating local indigenous populations. The working conditions in the mines were brutal, as miners were exposed to dangerous working conditions and poisonous gases (Brown 2001). Populations in indigenous communities near Potosí decreased, as miners died or left their home communities to avoid the draft and the dangerous work (Cole 1985; Wightman 1990). It has been estimated that as many as 8 million indigenous miners lost their lives to Andean mines and the *mita* draft during the colonial period (Lane 2019).

2.3.1 **American Development of the Patio Process**

The inability to extract silver from *negrillos* and tailings in the Andes plagued the Spanish crown throughout the 1550s and 1560s. Fortuitously, an alternative to smelting, called mercury amalgamation, was discovered in Venice in the mid-16th century. This new process did not need high temperatures to extract silver, thus offsetting much of the cost needed for charcoal fuel (Guerrero 2017:101). Through a series of chemical reactions, mercury was mixed with crushed silver ore to form a bonded alloy, or amalgam, with silver. Excess mercury was squeezed out of the amalgam (Figure 2.2), and then it was heated, which removed the remaining mercury through evaporation, leaving pure silver (Guerrero 2017:55, 102-103).

Following the discovery of mercury amalgamation, King Phillip II of Spain requested that European silver refiners bring the technology to the Americas (Guerrero 2017:109). Aided by German and indigenous refiners, Spanish merchant Bartolomé de Medina is credited with the first use of mercury to extract silver from American ores in Mexico in 1556 (Bargalló 1969; Bigelow 2020). However, the tricky *negrillo* ores still proved challenging to refine. It was not until Medina's discovery of adding a copper sulphate (the *magistral*) to the refining process that these ores were able to be fully refined (Bargalló 1955, 1969; Guerrero 2016). This discovery allowed silver sulfide ores to break down into silver chloride, which was then amalgamated with mercury to leave pure silver (Guerrero 2017).

Medina's new technique of combining mercury amalgamation with copper sulfate became known as *el beneficio de patio*, or the patio process, as it took place in large, open air patios within silver refineries (Guerrero 2017:103). It was a very complex and intricate process, and included many laborious, sequential steps[4]: grinding, drying, and salting the ore; mixing the ground ore with mercury and the *magistral* (copper sulfate); leaving the mixture to sit in the sun; washing it to remove the silver/mercury amalgam; evaporating the mercury from the amalgam; heating the silver to remove any last impurities; and finally forming the silver into bars or ingots (Figure 2.3) (Bargalló 1955; Bakewell 1984; Bigelow 2020). In Mexico, the only part of the process that involved heat was the last two steps. Otherwise, sunlight was the only heat source.

[4] In Figure 2.3, the many stages of the patio process are visible. These include water mills and stamp heads (*ingenios* and *piedras*) used to grind the ore, ovens (*hornos*) for heating ore, and large, square open-air patios for mixing the ore with mercury. Figure 2.3 also depicts llama caravans used to transport ore and refined silver in and out of the refinery, as well as a Catholic chapel and domestic residences for higher-status overseers and owners of the refinery.

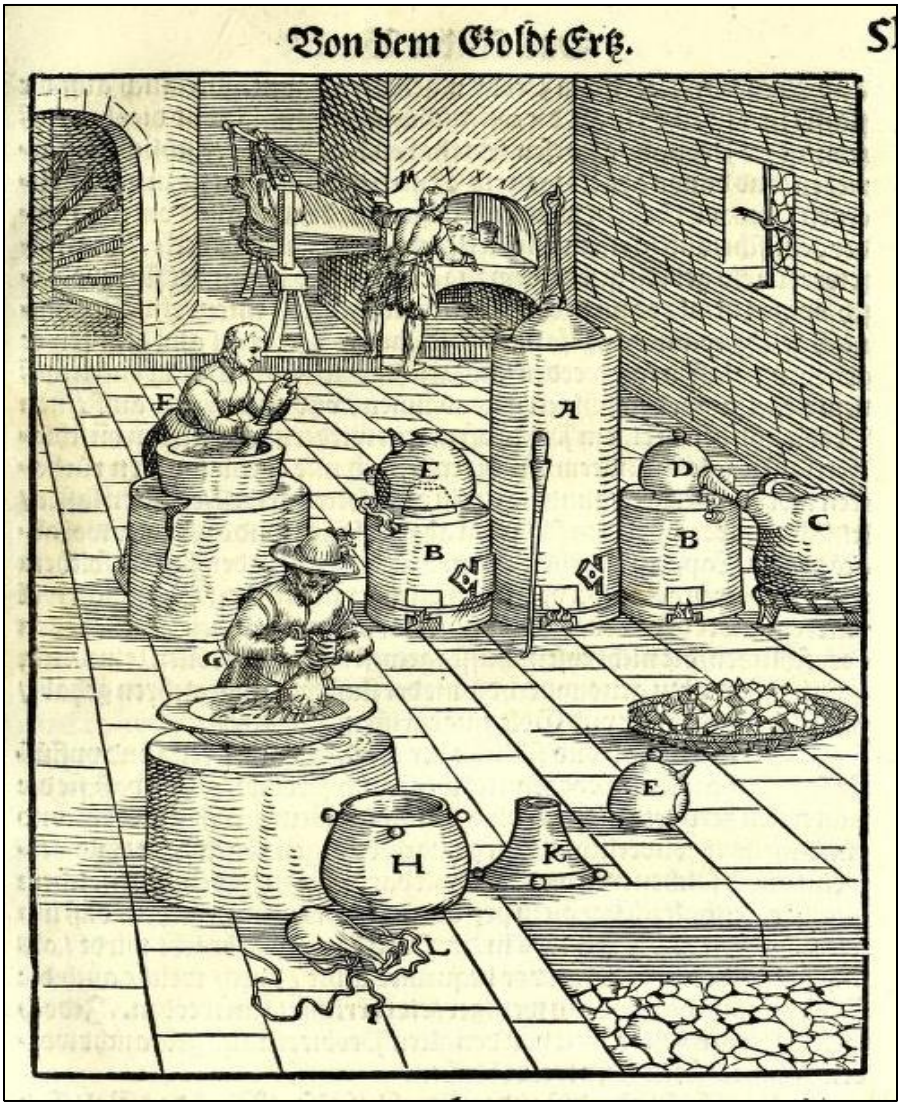

Figure 2.2: The amalgamation of gold using mercury. A man (G) is squeezing extra mercury from the amalgam through a leather bag. Ercker 1580:51.

Figure 2.3: Drawing ca 1705 depicting a silver refinery in Potosí. *Historia de la villa imperial de Potosí*, Bartolomé Arzáns de Orsúa y Vela. John Hay Library. Brown University.

2.3.2 **Bringing the Patio Process to the Andes**

Once the patio process was brought to the Andes by Fernández de Velasco in 1572, it made mining and refining reproducible on a massive, industrial scale. It was more cost-effective and efficient than either the European amalgamation method or the Andean *huayrachina/tocochimbo* method (Bargalló 1955). In Mexico, silver refineries using the patio process had to rely on imported, costly mercury transported from the Almadén mines in Spain. However, the Andes had a variety of local mercury mines, which lessened the high import costs and made the patio process even more appealing to local refining entrepreneurs. The Huancavelica mercury mines in the central Andes produced the largest amounts of mercury used for the patio process in the colonial period, although there were other mercury mines located throughout the southern Andes.

While cost-effective and efficient, the patio process was initially challenging to replicate in the Andes. This was due to the high altitude, cold weather, and marginal altiplano environment surrounding the Andean silver deposits. Heat from the sun was not enough to initiate the chemical reactions, and wood, charcoal, and dried llama dung (*taquia*) were needed as fuel to add heat to various steps. Local Andean refiners were tasked with adapting the patio process *in situ* (Bigelow 2020; Guerrero 2016). This included roasting silver sulfide ores with salt at the very beginning of the refining process to convert ores to silver chlorides, which was originally achieved by adding the *magistral* (the copper sulfate). Further, iron and copper were discovered to also reduce silver chloride to elemental silver, which was originally only thought possible by adding copious amounts of mercury. Both these developments occurred in the Andes, and they reduced the amount of costly mercury and copper needed in the process (Figure 2.4) (Guerrero 2017:121).

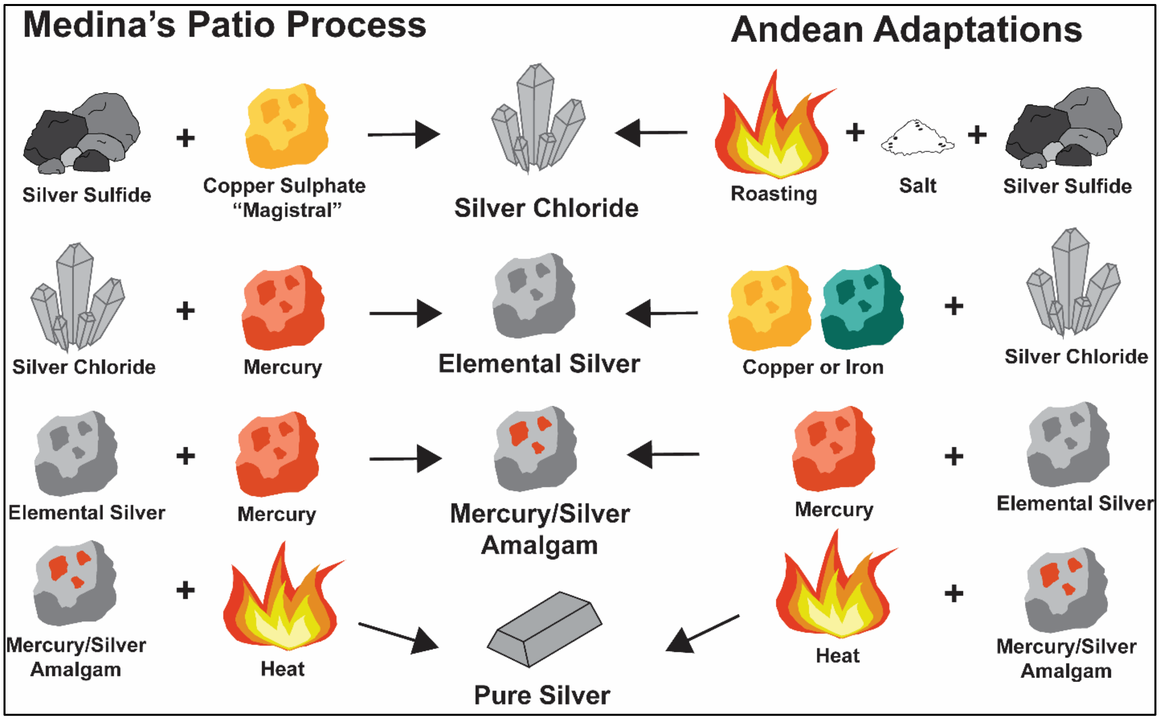

Figure 2.4: Visual representation of the patio process, with Medina's original Mexican process illustrated at left, and Andean adaptations to the process illustrated at right.

Once the kinks in the patio process were ironed out, the new Andean refining entrepreneurs quickly realized they required a dramatic increase in labor for this method. To begin, miners were now needed at both silver mines *and* mercury mines. Then, silver and mercury ores needed to be transported to silver refineries to conduct the patio process. The refineries themselves needed to be constructed, and large amounts of capital were needed in advance, as these were quite expensive. The refineries also needed to be built near water sources, which involved renting or purchasing land in remote locations near large enough water sources to create reservoirs and generate sufficient power to move water wheels needed for grinding. The early construction of these expensive refineries in the 16th century was often beyond the financial means of indigenous laborers, and they were usually owned and operated by wealthy Spaniards (Bakewell 1984, 1988).

The new refineries required a large amount of labor to operate, so the Spanish government needed to come up with a strategy to increase the number of laborers within the silver industry. This renewed pursuit of silver and mercury in the 1570s led to the creation of the colonial *mita* labor draft, introduced in the previous section. These reforms placed new draft levees on indigenous communities throughout the southern Andes. Whole families were drafted, including people in Paucarcolla in the Puno Bay, to work in Potosí under the leadership of their native authorities (*curacas*) (Bakewell 1984; Barragán 2017; Cole 1985).

Different families from each community were drafted each year to work in silver mines and refineries at Potosí, which meant each household was set to go every seventh year. The drafted workers (*mitayos*) included every male between the ages of 18 and 50 within a community. They were supposed to work 17 nonconsecutive weeks a year, which was usually one week on and two weeks off. When the *mitayos* were on their break or at rest ("*de huelga"*) they were allowed to work side jobs, and many continued to work in the mines and refineries. The labor force was divided into three labor groups and was based on a three-week rotation (Bakewell 1984; Barragán 2017:200; Cole 1985). *Mitayos* worked from Tuesday to Sunday, and often worked day and night during this one-week period (Hurtado Chávez 2008; Tandeter 1993).

Mitayo laborers at the Potosí mines worked alongside skilled and paid workers, called *mingas*. The *mitayos* would usually enter the mine with their own tallow candle and hammer tools, alongside a skilled *barretero* or pick-man, who was usually a paid skilled laborer (*minga*). The *barretero's* role was to drill holes in the tunnel using picks and tools, and to prepare the shots to remove quality silver. The *mitayos,* within the tunnels, would be tasked with transporting the ore from the tunnel to the shaft opening (Bakewell 1984; Cole 1985; Hurtado Chávez 2006; Domínguez 2006; Tandeter 1993).

Once the ore left the mines, it was transported to the silver refineries. Prior to the introduction of the patio process, the ore was transported to nearby smelteries. With the introduction of the patio process came a variety of new labor roles related to selecting, transporting, and sorting the ore so that it could be processed at the refineries. Earlier in the colonial period, the ore was transported to refineries by llama caravans (see Figure 2.3), which were often owned and operated by indigenous peoples. Later in the colonial period, the transport of ore was taken over by mule trains and muleteers (*arrieros*).

By the end of the 16th century, the patio process had been implemented throughout the Andes (Cole 1985). Silver refineries became ubiquitous on the mining landscape. In the following sections, I will examine both the technological and social aspects of silver refinery labor throughout the colonial period.

2.4 The Spectrum of Silver Refineries

After the enactment of the Toledan *mita* draft in the 1570s, just as many *mitayos* were sent to work in silver refineries as were sent to labor in silver mines (Bakewell 1984; Cole 1985). In the existing literature, silver refineries are usually defined as falling into two discrete types: either a *trapiche* or an *ingenio*. However, these “types” are less discrete than their labels indicate and ranged along a spectrum. In modern Spanish, the word *trapiche* is a synonym for *molino*, or mill, and it can refer to any type of mill used to process minerals, olives, or sugar cane (Figueroa 2008:89). The word *ingenio* is exclusively used to describe sugar cane mills, although in the past it was used to describe large-scale mineral processing centers (Figueroa 2008:89).

Ingenios have been most often described as the larger and more complex type of silver refinery, requiring larger amounts of initial capital investment (Bakewell 1984:19-22; Tandeter 1993:3). In the early 16th century, *ingenios* used both human and animal power to operate the ore-crushing machinery which often included multiple sets of large copper, iron, or tin stamp heads or mallets (*mazos*) (Figures 2.5 and 2.6) (Bakewell 1984:19; Cole 1985:19). However, water-powered mills using ore grinding mechanisms powered by vertical waterwheels was also a common type of *ingenio* (Tandeter 1993:3).

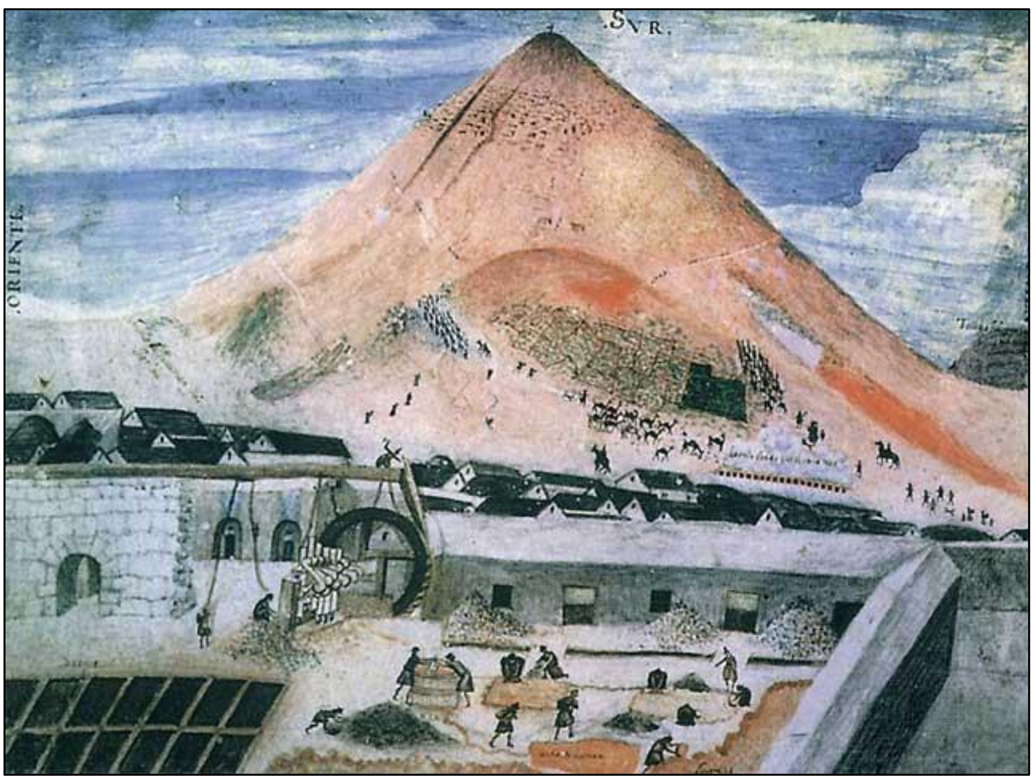

Figure 2.5: A silver refinery at Potosí, with the mine in the background. Hispanic Society of America [1590].

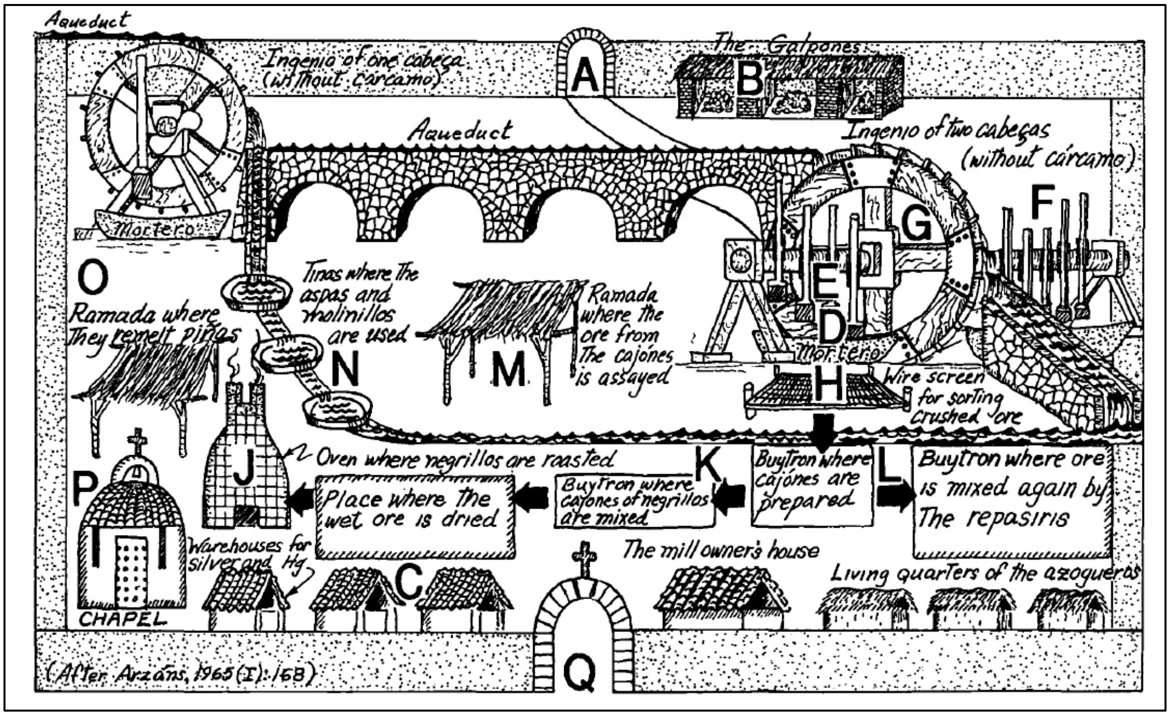

Figure 2.6: Drawing of a Potosí stamp mill ca. 1600 AD, taken from Craig 1993:135, based on the original from Arzáns 1965 I:168 (also Figure 2.3).

The labels in the refinery from Figure 2.6 include: A) The rear gate; B) *galpones* (storage sheds and/or laborer quarters); C) guarded warehouse for silver and mercury; D) *mortero* (large grinding stone); E) stamp heads; F) extra stamp heads; G) wooden axel; H) iron mesh for screening; J) oven/furnace used to roast ores; K) *buitrones* or bins to mix ores; L) *buitrones* where mixture is mixed by treading with feet; M) location to sort and assay ore; N) basins used to wash amalgam; O) location where amalgam was heated to remove mercury; P) chapel for worship; and Q) principal gate/front entrance.

Bakewell describes the typical *ingenio* as a large refinery with a rectangular wall roughly 50 m long on each side, with enclosed and open-air patios for work (1984:20). Inside the *ingenio* were buildings for storage and habitation, stone tanks for the amalgamation process, an open patio, a chapel, and the waterwheel and stamp heads. The grinding apparatus was large, with each iron stamp weighing over 45 kilos (100 lbs.), and the waterwheel measuring over 9 meters in diameter (Bakewell 1984:20). Each milling apparatus (a *cabeza de ingenio*) was connected to the wheel by a shaft and usually had between 6 and 8 stamps (*mazos*). Often, each wheel was connected to 2 *cabezas*, for 12-18 stamps. Some *ingenios* at Potosí may have had more than one waterwheel, meaning one *ingenio* may have had up to 36 stamps operating at one time (Bakewell 1984:20).

Mining dictionaries from the period describe *ingenios* as having a variety of characteristics, including canals, reservoirs, waterwheels, stamp heads, mallets, and grinding stones (Llanos 1983 [1609]:62; Langue and Salazar-Soler 1993:294-195). There were many varieties of *ingenios* (*ingenio de agua, ingenio de amalgamación, ingenio de barquines, ingenio de caballo, ingenio de dos cabezas, engenio de rastra, ingenio de mazos a pies*), and they varied depending on their level of investment. Some were powered by horses, others by human labor or water. The water-powered *ingenios* relied on a huge investment in water reservoirs and canals which captured and stored water during the rainy season. In large centers like Potosí, giant reservoirs made silver refining possible year-round (Tandeter 1993:3).

The owners of *ingenios* became known as *azogueros* (mercury specialists) (Craig 1993:33). The actual laborers of the *ingenios* were often categorized by their labor status and skill. For example, there were: *peones* (unskilled laborers); *trabajadores* (workers); *yanacona* (indigenous workers in service of a Spaniard); *mitayos* (conscripted indigenous laborers); *mingas* (wage laborers); *k'ajchas*[5] (self-employed laborers); and *esclavos* (enslaved Africans). The categorization became even more specific when labor was broken down between specific tasks (picking, breaking, separating, transporting, grinding, mixing, etc.). *Mitayos* who worked the stamp mill were called *morteros*, and more specialized laborers who worked the refining ovens were called *horneros* or *quemadores* (Robins 2011).

On the opposite end of the spectrum of silver refineries were *trapiches*, which were low-investment, small, and rustic (Rodríguez Ostria 1989:133; Tandeter 1993:85). They usually did not include a large stamp-head apparatus, which was quite costly. Because of their lower start-up costs, *trapiches* were able to compete with larger *ingenios* and attract investments from smaller capitalist ventures (Rodríguez Ostria 1989:133). The owners of *trapiches* were referred to as *trapicheros*, and they usually did not own mines in addition to their refineries. This is in contrast to *azogueros*, who usually owned both mining claims and *ingenios*.

Colonial mining dictionaries describe *trapiches* as mills with two rotating stone wheels, sometimes referred to as a *trapiche de rastra* or an *ingenio para moler metales* (Langue and Salazar-Soler 1993:598-599). In most cases, large rocks were used to grind ore, as opposed to the massive stamp heads at *ingenios*. The process was described as using two large stones, one of which lays on the surface of another, which are moved rapidly to grind ore (Figure 2.7) (Barragán 2017:207). This process resembled the indigenous *quimbalete* grinding stones (what Barba refers to as a "*maray*"), where two workers would move a grinding stone (shaped like a half moon) up and down to crush ore (Figure 2.8) (Bakewell 1984:198; Barragán 2017:207; Langue and Salazar-Soler 1993:599).

[5] There are a variety of spellings for the laborer term *k'ajcha*, including kajacha, k'aqcha, kaqcha, capcha, cagcha, and caccha. I follow Barragán 2017 and use the "*k'ajcha*" spelling.

Like the variety of *ingenios,* there were also many types of *trapiches*. Some trapiches were only the *quimbalete* grinding stone, while others were something more akin to small grist mills that traditionally used animal and waterpower to push "*rastras*" and "*codos*," grinding double the amount of material as a human-powered *quimbalete* (Rodríguez Ostria 1989:133). Some *trapiches* are also described as also having small ponds (*cochas*), in which processed ore was washed to later be combined with mercury and salt (Craig 1993:146).

The owners of *trapiches* were referred to as *trapicheros* and were often lower status than the *azogueros.* This was because *trapiches* needed less capital to own and operate, and they were easier to use in independent enterprises (Gil Montero and Téreygeol 2021:66). This made ownership by indigenous, *mestizo*, and poor Spaniards much easier. Because many *trapiches* were owned by lower-status people, they were often accused of partaking in illegal or semi-illegal activity. *Trapicheros* were distinguished from *azogueros* during the 17th century in this way:

> *…deduscase de esto que sin abundancia de azogue no puede haber riqueza, y hacerse general a las diferentes clases de los destinados al descubrimiento y trabajo de las minas, pues las preferencia que tienen en Potosí los Azogueros dueños o arrendatarios de ingenios para tomar azogue del Banco, es sumamente perjudicial a los trapicheros que trabajan en pequeños molinos, y son muchos en esta dicha Villa, sufriendo todos, o los mas, unas suspensiones considerables en su exercicio en tiempo de escasez… (Archivo General de Indias, Buenos Aires, 434, requoted in Langue and Salazar-Soler 1993:599).*

> …It should be deduced that without an abundance of mercury there can be no wealth, and it cannot become available to the different classes of those destined to work in the mining industry, as there is a preference in Potosí to provide Bank-loaned mercury to the Azogueros and owners of ingenios, which is extremely damaging to the trapicheros who work in small mills, and there are many of these in this said Villa, all of whom suffer, or the majority, due to considerable breaks in activity during times of scarcity ... (Archivo General de Indias, Buenos Aires, 434, requoted in Langue and Salazar-Soler 1993:599. English translation my own).

In short, *trapicheros* were viewed as being lower-status, with less capital, and with less ability to receive bank-backed loans for the all-important mercury that was needed for the patio process. In times when mercury was especially difficult to import to Potosí, the powerful *azogueros* controlled the mercury supply, making it difficult for *trapicheros* to continue their own refining practices.

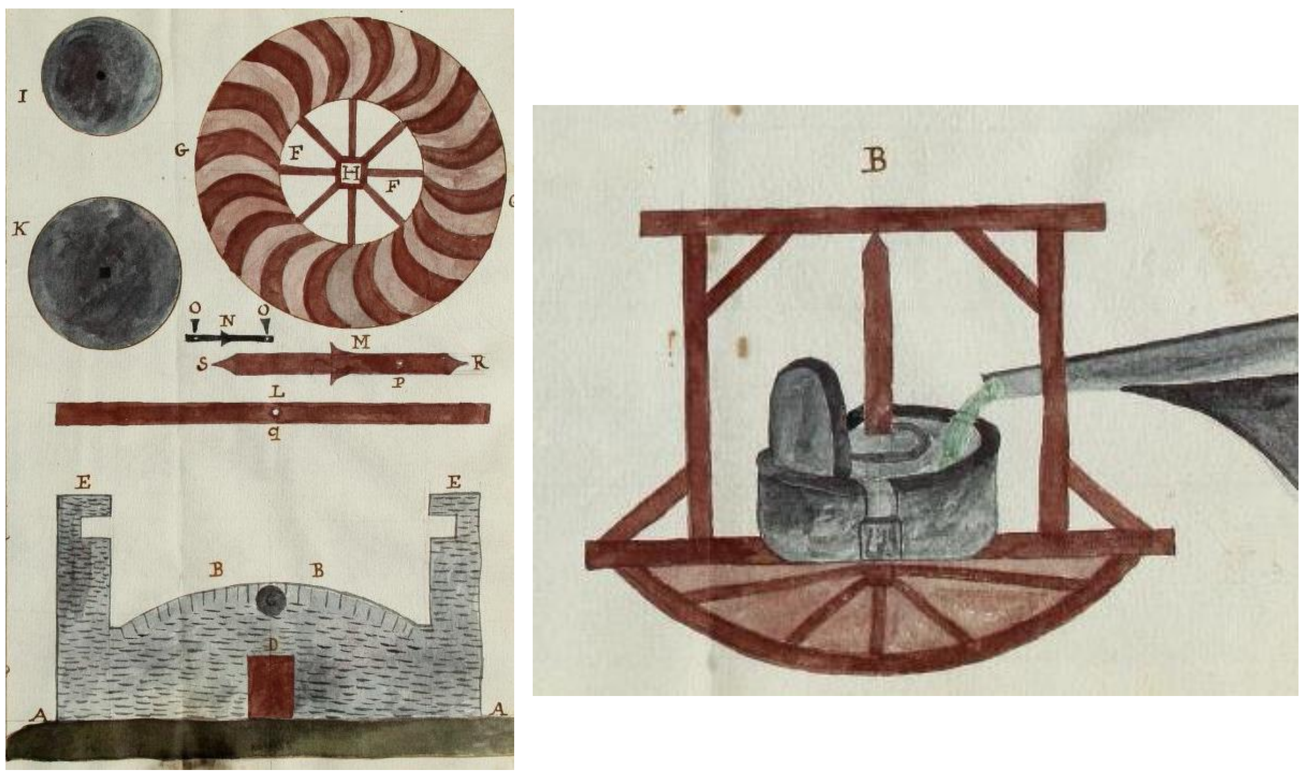

Figure 2.7: Hand-colored folded plates from the 1789 manuscript "Medidas de minas y beneficio de los metales según Gamboa y otros para el uso de su dueño." Each plate depicts the construction of a trapiche. Codex Sp 139. John Carter Brown Library.

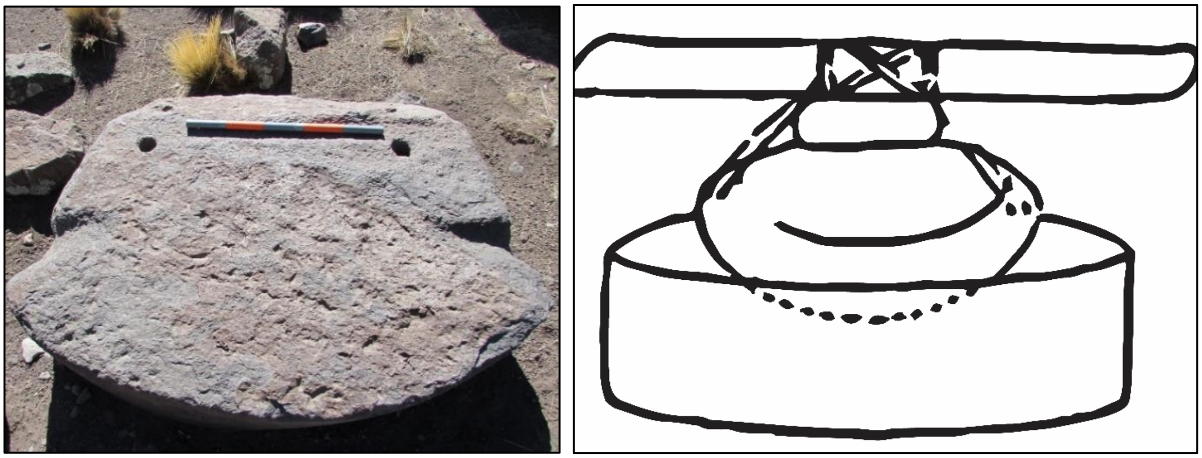

Figure 2.8: (left) A quimbalete from Chorrillos in the Puno Bay, (right) a drawing of a quimbalete, retraced from Hurtado Chávez 2008.

The practice of *kajcheo*[6] is commonly discussed in relation to *trapiches,* instead of *ingenios. Kajcheo* was a semi-illegal practice where laborers took advantage of rest days to work in the mines, taking any ore they could find for themselves, to later be refined at a *trapiche* (Tandeter 1993:85, 90). These workers, called *k'ajchas*, were often described as silver thieves. However, their role was more akin to self-employed workers (Barragán 2017:194), and they often worked in mines and refineries amongst free laborers (*mingas*) and forced laborers (*mitayos*). Often, *mingas* and *mitayos* used their free rest days to work as *k'ajchas* (Barragán 2017; Rodríguez Ostria 1989). Many *mingas* and *mitayos* worked as *k'ajchas*, although not every *k'ajcha* was a *minga* or *mitayo* (Barragán 2017).

K'ajchas were constantly under surveillance from the Spanish crown and various mining ordinances attempted to regulate this process over the centuries. Issues arose when miners would save the richest silver veins for their *k'ajcha* days and then send the high-value ore to non-regulated

[6] Similar to my use of the term *k'ajcha* for the spelling of the individual laborer, I use the spelling form "kajcheo" for the practice itself.

trapiches for processing (Rodríguez Ostria 1989; Tandeter 1992). In Potosí, this practice occurred as early as the late 16th century, although by the mid-18th century the practice had become much more visible and frequent (Barragán 2017:207).

Trapiches also represent one of the only locations where laborers were able to have direct access to ore, and thus a type of wage and income, which served to attract many different types of laborers to these refineries (Tandeter 1993:90). Laborers could take their own silver ore from their *k'ajcha* days to *trapiches* for processing, often either processing it themselves, or paying a small fee to get it processed. In either case, the laborers were able take the refined silver from the *trapiches* and sell it for their own financial gain, without having to deal with the high fees or governmental regulations that were common at the *ingenios.*

In Potosí, this meant that *mitayos* who participated in *kajcheo* were able to raise enough money to allow them to travel home, paying off their *mita* labor quota. This also allowed *mitayos* the opportunity to stay longer at the mining center if they wished and become self-employed workers, after having already paid off their term of service (Tandeter 1993:90). Because *trapiches* were associated with *k'ajchas* and semi-illicit dealings, they were also locations where marginal populations like indigenous people, *mestizos*, and women could carve out some autonomy and economic stability (Rodríguez Ostria 1989:125).

There were other mixed forms of coercive labor relationships at *trapiches* and *ingenios* in the colonial Andes. At Potosí, many of the laborers in the refineries who worked directly with the stamp-heads and grinding apparatuses were listed as "forced" laborers (likely *mitayos*), while those that did other tasks were "free" laborers (*mingas, k'ajchas, voluntarios,* etc.) (Tandeter 1981). Historical sources from Pacajes, Bolivia, discuss how *mitayos* who were drafted to work at Potosí were required to meet before they set off on their journey. If anyone locally wanted to hire the *mitayos* for their own work, all they had to do was pay 150 pesos, which would cover the *mitayo's* yearly labor obligation. Often the local community leader (the *curaca)* would purchase the laborer's *mita* obligation for local work necessary to the community (Boccara 2002:147-148; Cole 1985:39). In Pacajes, these laborers became known regionally as *indios maharaques* (*indios de año,* in the Aymara language) and made a wage of 2 *reales* per day for work in local mines, refineries, farms, and ranches (Cole 1985:39).

2.5 Between Trapiche and Ingenio

As I have hinted at in the preceding section, the simple, discrete categorization of *trapiche* and *ingenio* into two "types" of silver refineries is problematic. Interesting, although *trapiches* are mentioned in various primary sources, the word *trapiche* does not appear in the dictionary of mining terms produced by García de Llanos in 1609. However, Llanos does include the term *ingenio,* although his definition could easily be applied to both *ingenios* and *trapiches.* He states that the term refers to a wide scope of refining activities, but principally it is a place used to grind metal (Llanos 1983 [1609]:62). Additionally, García de Llanos describes *ingenios* as generally consisting of the following:

> *canal, chiflón, rueda, eje, quijo, cureñas, chumaceras, castillo, triangula, cabezales, cadenas, mazos, levas, sobarbos, almadanetas, tejos y mortero (Llanos 1983 [1609]:62.*

> canals, channels of fast-following water, water-powered wheels, axels, ore, wooden frames, bearings, walls, stamp heads, chains, stamp head mallets, cams, waterwheel blades, iron mallets with long handles, iron disks and winches, and mill stones (Llanos 1983 [1609]:62. English translation my own).

While a few of these items are usually only associated with *ingenios* (stamp heads and mallets), most of the list of *ingenio* attributes could easily be applied to *trapiches* as well.

To complicate matters further, *trapiche* and *ingenio* are often discussed as synonyms in other locations in the Americas, such as Mexico, Chile, and Argentina (Figueroa 2008). Insights on these complications come from San Antonio de Nuevo Mundo, in Lípez, Bolivia. Scholars combine historical and archaeological data from the Lípez region, documenting numerous *trapiches* and *ingenios* over the long-term trajectory of the region, following the mining cycles through boom and bust years, highlighting the use and reuse of many of these refining locations (Gil Montero and Téreygeol 2021).

The Lípez refinery study highlights how varied the uses of *ingenios* and *trapiches* were in the southern, rural Andes (Gil Montero and Téreygeol 2021). Further, scholars identified new "types" of refineries that fall outside Bakewell's (1984) classic types described for Potosí. Colonial Lípez refineries included *ingenios* with only eight total *mazos* (mallets), as well as *ingenios de repaso* which did not have mills, but included patios to refine already ground ore. Many Lípez silver refineries do not follow any "type" at all and were built in a way that accommodated the topography of the region.

The Lípez study also found that individuals listed as *azogueros* owned both *ingenios* and *trapiches*. Further, some *azogueros* did not even own a refinery, and were listed simply as overseers of certain sections or patios of a rented *trapiche* (Gil Montero and Téreygeol 2021). This included renting available patio spaces within *trapiches* to have *mitayos* under their control grind and process ore from their mines using *quimbaletes*. In Lípez, boom periods of production at San Antonio de Nuevo Mundo show little evidence for indigenous ownership of either *ingenios* or *trapiches*. However, during its decline, there was evidence of both indigenous and *mestizo* owners of refineries. These results emphasize how refineries were used differently during boom and bust periods, as well as how they were reused in a variety of different ways over time.

The recent work at Lípez and San Antonio de Nuevo Mundo has emphasized the variable nature of silver refining technology and labor throughout the colonial period. It has shown that it is best to view silver refineries on a spectrum, instead of separated into two discrete categories. In some areas of the colonial Andes, there were larger-scale, higher-investment refineries that were usually owned by Spaniards. On the other end of the scale, there were smaller-scale, low investment, and sometimes illegal refineries, owned by indigenous or *mestizo* individuals. And in other cases, the smaller-scale refineries were rented out by powerful individuals to refine their own ore when they did not have their own refinery available.

2.6 Daily Life Inside a Refinery

The work in colonial Lípez has shed light on the complicated, nuanced operations of colonial silver refineries, especially those in more marginal locations in the Andes. During boom periods of production, colonial social norms were stricter, but during bust periods and decline in production, rigid social norms appeared to ease, especially regarding ownership and forced labor practices. While the Lípez study provided an invaluable view into the long-term organization of silver refining technology, scholarship is still murky when it comes to daily life and living conditions for laborers within the actual refineries themselves. In this section, I present archaeological and historical data on what is known about social life within silver refineries, and I argue that some of the more rigid social norms of colonial Spanish society did not apply to these spaces, especially within smaller, marginal refineries such as those in the Puno Bay.

2.6.1 **Material Remains of Refinery Life**

Recent archaeological work has examined the remains of colonial refineries near Porco, Bolivia (Craig 2000; deFrance 2012; Van Buren and Weaver 2012; Weaver 2008). Weaver has argued that women lived at the large-scale silver refinery of Ferro Ingenio based on evidence of spindle whorls and *tupu* shawl pins (2008:63, 81). DeFrance has similarly argued for the presence of women in mining contexts at Porco based on evidence of an indigenous *k'oncha* fireplace found within a high-status household at Cruz Pampa on the outskirts of Porco (2012:12-13).

Large, rectangular buildings at these sites have been identified as chapels (Craig 2000), and nearby structures are argued to have been the residences of refinery owners and overseers. A structure believed to have been the household of a high-status overseer at Cruz Pampa contained the remains of a European male shoe, a pipe, and jewelry (deFrance 2012:13). Housing for indigenous laborers is less evident at these sites and some scholars hypothesize that temporary shanties for laborers were built near work areas (Craig 2000:133), while others argue that storage structures were intermittently used as worker barracks (Weaver 2008:78). In either case, these low-cost structures are harder to identify in the archaeological record.

2.6.2 **Paid and Unpaid Labor on the Way to the Refineries**

Much of what we know about labor in silver refineries in the colonial Andes comes from Potosí. During the 16th and 17th centuries, Potosí mine owners (*mineros*) relied on both *mitayos* and *mingas* (self-employed free laborers) to extract ore in mines and refine ore in refineries. *Mitayos* were used to carry and transport ore in the mines to the mine openings. More skilled labor tasks, such as mining the ore with picks (done by *barreteros)* and breaking it into smaller pieces within the mine (done by *brosiris*), was usually done by free laborers, many of whom had a great deal of prior experience and skill (Tandeter 1993:3). *Palliris* evaluated the ore to see whether it contained sufficient silver to be sent to a refinery (Tandeter 1993:3). If the trained *palliri* approved the quality of the silver, the ore was then transported to a refinery by a muleteer or llama caravan.

In the Lampa Province, just north of the Paucarcolla Province (where Puno is located), laborers were making decent money for their skills by the end of the 18th century at the Pomasi and Victorias mines. They were paid by their skill level, with more money going to the overseer (12 pesos/day) and *barreteros* (6 pesos/day), than the *palliris* (2 pesos/day) and young apprentices (*pollos*; 3 pesos/day). By this time, regular, unskilled miners were also paid, instead of conscripted, and made a daily general wage of 4 pesos/day (Rivero y Ustáriz 1857, Volume 2:10). Laborers who performed good work could be paid an increase of one peso more per day.

The muleteers and transporters would usually come to the Lampa mines on Fridays and Saturdays, using llamas and mules to transport the ore to the distant refineries. They were paid by distance from the Pomasi and Victorias mines to the Lamparaquen and Santa Rosa refineries:

> *De Pomasi al trapiche, distante dos leguas, reciben cuatro pesos por cajón. Por el transporte al de Palca se les dan seis por las cuatro leguas, satisfaciéndose el acarreo a la distancia de seis leguas a razón de siete pesos, y el cajón para Lamparaquen, que dista nueve leguas, a razón de nueve. La mina de Victorias paga seis reales por el acarreo de cuatro quintales y medio de metal rico al trapiche de Santa Rosa, y cinco por el de menos rico (Rivero y Ustáriz 1857, Volume 2:10).*
>
> From Pomasi to the *trapiche*, which is a distance of two leagues [8 km], they receive four *pesos* per crate. For transport to Palca, they are paid six [*pesos*] for four leagues, and six leagues results in a payment of six *pesos*, the crates that go to Lamparaquen, which is nine leagues away, are charged at a rate of nine [pesos]. The Victorias mine pays six *reales* for the transport of four and a half *quintales* of ore to the Santa Rosa trapiche, and five [*reales*] for most others (Rivero y Ustáriz 1857, Volume 2:10. English translation my own).

This passage reveals how, by the end of the 18th century, Andeans in the mining sector in the western Lake Titicaca Basin were making a decent living for their efforts. Especially lucrative was the job of transporting ore from the mines to the refineries, as the transporters charged per crate of ore. These records also show that refineries were often quite distant from the mines themselves, as ore from Pomasi was sent up to 9 leagues away (38 km).

2.6.3 Labor Roles Inside the Refinery

In Potosí, labor roles within the silver refineries differed among *mitayos*, enslaved Africans, and *minga* free laborers (Table 2.1). Potosí silver refineries tended to have Spanish or *mestizo* administrators and overseers who oversaw the refining process and controlled goods and labor in and out of the refinery. Conscripted *mitayo* indigenous laborers performed the hard labor inside the refineries as *mortiris*[7]. This role involved taking the ore and grinding it into a fine powder using either stamp heads, a grist mill, or a human-powered *quimbalete* (Tandeter 1992). Other free laborers worked as *repasiris*, who oversaw mixing the ground ore with mercury, salt, and other elements, often with their bare feet.

In colonial Puno, silver ore was processed at both *trapiches* and *ingenios* (Galaor et al. 1998:144). Inside the refineries, the ground ore was first taken to be roasted with salt in reverberatory furnaces, and then placed in mixing containers (*buitrones*) in the patio. Laborers[8] added salt, mercury, and other add-ins to the *buitrones*, as well as heat to encourage the amalgamation process. Once the amalgam (*pella*) was formed, the mixture was taken to watertight tanks (*potros*) where the *repasiris* agitated the mixture with their feet, and the heavy *pellas* sank to the bottom and were collected. Extra mercury was squeezed out of the *pellas*, which were then

[7] Also spelled *morteros.*
[8] In this case, sometimes called *horneros* or *quemadores.*

placed in pineapple-shaped molds (*piñas)* and heated in a smaller oven, where the mercury evaporated, leaving behind pure silver (Galaor et al. 1998:144-145).

Table 2.1: Workers in Mines and Ingenios in 1790, Potosí.

		Indians		
Worker	**Spaniards**	**Mitayos**	**Mingas**	**Total**
Mines[9]				
Administrator	X			
Cancha minero	X			
Apiris		1,509	409	1,911
Barreteros			517	517
Brosiris			303	303
Palliris			250	250
Pongos			72	72
Ingenios				
Administrador	X			
Mayordomo	X			
Mortiris		867		867
Mortiris and Repasiris			1,039	1,039
Total		**2,376**	**2,583**	**4,959**

2.6.4 Ethnicity and Gender in Refineries

While life within refineries was more nuanced than traditional labor roles suggest, the ownership of *ingenios* and *trapiches* did have different socioeconomic insinuations (whether real or imagined). *Trapiches*, given their small and marginal nature, were often associated with more illicit and ad-hoc activity. Generally, *trapiches* were associated with indigenous, *mestizo*, or *mulato* (mixed black ancestry) silver merchants (Barragán 2017:196). In contrast, *ingenios* were

[9] Data from Tandeter 1992:38. Worker translations: *administrator* (manager); *cancha minero* (laborers in the courtyard where ore was stored); *apiris* (ore carriers); *barreteros* (pick men); *brosiris* (ore crushers); *palliris* (ore sorters); *pongos* (guards); *mortiris* (mitayos who crushed ore in refineries); *repasiris* (barefoot workers who mixed ore with water, salt, and mercury in refineries).

more associated with wealthy Spaniards, or European entrepreneurs (Weaver 2008). In Potosí, the *trapiches* were located within the indigenous neighborhood, while the *ingenios* were located along the river and *Rivera* outside of the city (Tandeter 1993:91).

Most often, *trapicheros* (*trapiche* owners) did not own silver mines, and so did not control the entire system of production, like many of the well-off *mineros* and *azogueros*. Instead, *trapicheros* depended heavily on the *kajcheo* (Tandeter 1993:85, 90). *Trapicheros* were often accused by mine and *ingenio* owners of encouraging the theft of high-quality ore by mine laborers, as well as incentivizing this theft by offering alcohol or money in advance of receiving the stolen ore (Rodriguez Ostria 1989:134). By the mid-18th century, less than 30% (n=58) of the *trapiches* in Potosí's indigenous quarter were owned by Spaniards, compared to over 70% (n=160) owned by indigenous entrepreneurs (Barragán 2017:208).

Kendal Brown argues that many of the indigenous *trapicheros* at Potosí likely used indigenous smelting technology, such as *huayrachinas* and *tocochimbos*, to refine high-grade ores in combination with the patio process and mercury amalgamation techniques well into the 18th and 19th centuries (Brown 2017). *Trapicheros* were also able to process their own ore outside of the system controlled by Spanish mine owners and *azogueros* (Barragán 2017).

Women, both Spanish and indigenous, also had important roles in the silver mining economy of colonial Peru. Many authors have stressed their importance in trade and markets, especially in Potosí (Larson 1983; Mangan 2005; Zulawski 1990, 1994, 1995). Women also worked in industries related to the mining sector, such as candlemakers, and even repurposed silver refineries as ceramic workshops (Bigelow 2020). Recent historical studies (Barragán 2017, Bigelow 2016, 2021; Velasco Murillo 2013, 2017) have also shown the importance of women in the silver refining process, as well as in trading ores.

Evidence of women in mining and refining sites has been identified by archaeologists, such as the presence of *tupu* shawl pins, beads, and spindle whorls for weaving (Weaver 2008). Bigelow (2012, 2016) has identified examples of female mining knowledge present in colonial legal cases, documenting over one hundred cases of female miners and refiners in the Andes throughout the 16th – 19th centuries. Women and children did travel with *mitayo* men from their home communities and were supplied provisions for their journey and stay in Potosí. In the late 16th century, women and children are documented as working as *mingas* at Potosí. Their jobs are described as sifting ground ore for about two *reales* per day, or about half the wage as a *mitayo* (Bakewell 1984; Barragán 2017:205).

Bigelow (2020) argues that the majority of *pallaris* (those who sorted good ore from tailings, done at mine entrances and refineries) were women. According to Bigelow, the term *palliris* comes from the Quechua and Aymara words *pallani* (gather by hand) and *pallatha* (collect), similar to the Inka word for noble woman, *palla* (Bigelow 2020). *Pallar* was used to describe the washing and separating of the silver-mercury amalgam (*pellas*) in refineries, and again, this work was usually done by women (Figure 2.9) (Bigelow 2020; Llanos 1983 [1609]).

In a Potosí mining report from 1761-1762, both men and women were listed as indigenous *trapicheros* (Barragán 2017:208-209). While most owners were men, women did make up 15% (n=29) of the *trapiche* ownership (Barragán 2017:208-209). Further, the report documents that 20% of people with access to ore (these could be *k'ajchas* as well as *trapicheros* or *azogueros*) who then sold it to a bank were women (n=99), providing proof that women were involved at many stages of the silver refining process (Barragán 2017:211).

Figure 2.9: Silver refinery from Chile in the 1830s. John Carter Brown Library.

2.6.5 **Food and Provisions in a Refinery**

We know that men, women, and children worked at refineries, and that some refineries were located up to 10-30 km away from mines and mining camps. What remains unclear is who cooked for the refinery laborers, how food was imported to the refineries, if it was grown and raised locally, and how provisions were allocated at the refineries. The 19th century mining report from the Lampa Province north of Puno, mentioned above, discusses how silver refineries, and the muleteers who transported the ore to the refineries, were provisioned with food:

> *Además de esta paga se les gratifica con el acullico, como llaman ellos, de una o dos libras de coca. También están los dueños de minas obligados, por costumbre antigua, a satisfacer por los indígenas que trabajan en sus minas y trapiches los tributos, casamientos, bautismos, alferazgos y otras pensiones que los gravan según estilo de los lugares. Es de advertir que los dueños les pagan casi todo el trabajo en coca, maíz y chuño, dándoles la libra de coca a peso; la arroba de maíz al mismo precio, y el chuño al seis reales (Rivero y Ustáriz 1857, Volume 2:10.)*
>
> In addition to this payment, the transporters [muleteers] are rewarded with the *acullico*, as it is called, of one or two pounds of coca. The mine owners are also obliged, due to old customs, to pay the indigenous mine and refinery workers in tribute goods, weddings, baptisms, military appointments, and other pensions according to the tax system of each location. It is noteworthy that the owners pay their workers mostly in coca, maize, and chuño, selling them a pound of coca for a *peso*, an *arroba* of maize is the same price, and *chuño* for six *reales* (Rivero y Ustáriz 1857, Volume 2:10. English translation my own).

This passage reveals the enduring nature of local Andean systems of economy and payment in the silver mining and refining sector throughout the 19th centuries. Instead of monetary payment for their efforts, indigenous miners, refineries, and transporters were paid in societal activities and goods, such as foodstuffs like coca and *chuño*, as well as in ceremonies and events, like weddings and baptisms. Refinery workers appear to have maintained an Andean diet well into the colonial period, with staples including maize, tubers, and coca.

Monthly expenses[10] for the *trapiche* at Lamparaquen are also detailed in this 19th century report (Table 2.2), which include various forms of fuel, such as *taquia* (dried llama dung), charcoal, and wood (Rivero y Ustáriz 1857, Volume 2:20). Other expenses are also listed, such as food, including dried meat, maize, barley, and coca (Rivero y Ustáriz 1857, Volume 2:20).

[10] Abbreviations in the report are: ps = pesos; rs = reales; as and ars = arroba (about 25 lbs.); Chal. = chalona or charqui (dried beef); Ceb. = cebada (barley), or cebo (fodder), but cebada makes more sense. Chal could be a misspelling of chuño (freeze-dried potato), as this was a very popular local food staple. However, because the report lists nonlocal food expenses (coca, maize), it is very likely chuño was procured locally through other channels and would not necessarily show up on this expense report.

Table 2.2: Monthly Expenses From the Lamparaquen Rrapiche.

	Plata		**Coca**		**Maíz**		**Chal.**	**Ceb.**	
	ps.	rs.	as	lb.	ars.	lb.	Num.	as	lb.
1st Week	15	2	1	8	33	14	12		18
2nd Week	32	2	1	12	38		8		16
3rd Week	31	4	1	12	37	23	16		17
4th Week	33	4	1	18	39	23	18		18
Grand Total	**112**	**4**	**6**	**-**	**148**	**13**	**54**	**2**	**19**
Total	111	12	4	50	147	60	54		69

At the Lamparaquen refinery, the food payments to the refinery laborers were taken out of their wages. Instead of provisioning the laborers *and* providing them with hourly wages, the *trapichero* paid the workers in Andean food staples (Rivero y Ustáriz 1857, Volume 2:20). This limited the ability of the refinery laborers to save money and suggests most of their provisions were deducted from their salary. This abuse of power is similar to mining "company stores" seen in the 19th and 20th centuries in the United States, where mine laborers were paid their wages in company scrip, only exchangeable in company stores with highly inflated prices for food and tools.

While the Lamparaquen expense report indicates abuse of power by refinery owners, it also suggests some indigenous individuals were able to carve out an important niche in the trade of fuel to silver refineries. Indigenous herders who raised llamas and alpacas likely earned a substantial living by selling llama dung (*taquia*) to silver refineries throughout the Puno Bay. Fuel was a constant need at these locations, and charcoal and wood were often hard to come by in the *altiplano* environment. As I will show in Chapter 7, llama dung was a popular fuel source for silver refineries in the Puno Bay throughout the 17th and 18th centuries.

2.6.6 **Higher-Status Life in a Refinery**

One of the ways historians have understood daily life and living conditions within colonial refineries is through wills left by refinery owners, discussing possessions the higher-status owners left inside of their refineries. One such document is the will of Gaspar de Salcedo from 1692 which lists refining equipment, as well as his own possessions, left inside the field house inside his Puno Bay refinery, named Nuestra Señora del Rosario:

> *Que por hazer amistad y buena obra al Licenciado Don Luis de Pineda, deseando verte sacerdote le funde una capellanía en el Yngenio nombrado Nuestra señora del Rosario, por ser como es mío... Declaro que tengo por vienes míos el Yngenio nombrado Nuestra señora del Rosario que esta corriente y moliente, con todos sus aperos y peltrechos [pertrechos?] necesarios. Y así mesmo, tengo en el veinte y cinco o treinta cajones de metal molidos y por ser como ser de corta ley no los he beneficiado. Y así mesmo tengo en el dicho Yngenio algunas herramientas de barretas, azadones y otros géneros, y unas balansas con sus pesas grandes, con todo lo demás que pareciere en dicho almacén, por ser como es mío... en el Yngenio tengo la sala de mi vivienda colgada toda ella con colgaduras de tejidos de cumbe de diferentes colores; y así mesmo la recamara de la dicha sala, que es el dormitorio que está colgada de tafetanes con sus flecos de seda; y así mesmo en dicha recamara una cuja dorada de cama de campo ...tengo diferentes pinturas y quardos, y un altar de un santo christo con su dozel y cielo; y así mesmo una Ymagen de Nuestra Señora (Huratado Chávez 2008:38-39, taken from Frisancho Pineda 1996:81-87, testamento de Gaspar de Salcedo, 1692).*
>
> That, for the friendship and good work of the Licenciado Luis de Pineda, wishing to see a priest take on the position of chaplain of the Nuestra Señora del Rosario *ingenio*, as it is mine…I declare that I own the Nuestra Señora del Rosario *ingenio*, and that is operational for grinding ore, and includes all its implements and necessary equipment, and additionally, I have 25 or 30 crates of ground silver ore, which have yet to be refined. Further, in the said *ingenio*, I have some picks and tools, hoes, and the like, as well as some weighing scales with their large weights, and everything else that is within the said storehouse, all of which is my own…in the *ingenio*, I have decorated the living room of my house there with wall hangings made of multi-colored weavings; which are likewise hung in the bedroom; the bedroom also includes silk taffeta hangings; and within the same bedchamber is a gilded bedframe of a sleeping cot…I also have different pictures and paintings, and an altar of holy Christ with his canopy and heavenly sky; and I also have an image of Our Lady (Huratado Chávez 2008:38-39, taken from Frisancho Pineda 1996:81-87, testament of Gaspar de Salcedo, 1692. English translation my own).

This first portion of this will is potentially less surprising, at it lists basic tools and materials one would expect at a silver refinery, such as picks, hoes, and weighing scales, as well as a storage shed, and various crates of unrefined ground ore that have yet to be processed. Other contemporary documents from the period discuss other refinery supplies, such as “salt, lime, charcoal, mercury, wood, sledgehammers, pickaxes, and other mining tools and ore” (Tandeter 1992:160-161).

The second half of Gaspar de Salcedo’s will provides a window into the high-status and luxurious lives of refinery owners, even inside a rural refinery outside of the city. Gaspar de Salcedo’s will lists expensive wall hangings, textiles, paintings, and religious tokens, as well as a gilded camp bed, that were part of his refinery house. Other silver refineries from the period, such as one from La Plata in 1572, list expensive food and Castilian wine for the refinery owners and administrators inside a refinery (ABNB, EP 24: 365-366v).

2.7 Phase Two of Silver Refining (18th Century)

As the preceding sections have shown, life inside colonial silver refineries was varied, presenting degrees of inequality, as well as space for earning a living. Much of the opportunities for indigenous laborers grew in the 17th and 18th centuries. This period was a second or even third phase of silver mining in the Andes, following the initial mining boom at Potosí in the 1550s, as well as the introduction of the *mita* labor draft and the patio process of mercury amalgamation in the 1570s. From the mid-17th century onwards, Potosí never regained its grandeur, and there was less control of the *mita* draft, alongside a slow development of wage labor. This period also saw the construction of more colonial roads, larger cities, and a more cosmopolitan makeup of people at these sites. There was also a great deal of movement of people. Indigenous laborers had fewer ties to their home *ayllu* communities, and more movement was common throughout the Andes following the devasting labor drafts and disease outbreaks of the 16th century (Wightman 1990).

2.7.1 Migration, Rotation, and Movement

Work at silver refineries was seasonal, providing laborers a rotation of work throughout the calendar year. Records of *trapiche* sales from the Bank of San Carlos in 1762 show an increase in sales during the rainy season (Barragán 2017:211). Barragán found that between the months of January and March, almost 60% of all *trapiche* sales occurred. This evidence indicates that work in the silver refining industry was concentrated in a few months of the year when the rains raised the river levels and allowed for enough waterpower to move the mills. Because the work was seasonal, laborers only lived at the refineries for a few months of the year, so disruption to their daily lives would have been less strong. It is likely that laborers came to the Puno Bay for a few months of the year, but then moved on to other opportunities. This may have been their own agropastoral activities, or it may have been further mining or colonial market activities. Especially important may have been the raising of llama herds to transport materials throughout the colonial Andes, as well as selling llama dung (*taquia*) to silver refinery owners for much-needed fuel. This type of yearly rotation, where certain jobs were performed in different months depending on weather and the farming and religious cycle, was quite normal for the 18th and 19th century Andes (Platt 1995:270-271). It was likely also normal in the Puno Bay by the 18th century.

2.7.2 **Wage Labor**

Wage labor was also much more common in the Andes by the 18th century, by the 2nd phase of silver mining. Paid labor in mining contexts was often done by *mingas*, which was a separate category of worker from the coerced *mitayos*. However, recent historians have argued that instead of dual labor system in the mining industry, *mitayo* and *minga* labor "overlapped and interpenetrated" each other, and that the system should be understood as interconnected (Barragán 2017:203). *Mitayos* worked as *mingas* during their free weeks, so the same individual could serve both roles, just at different times throughout the year. The system combined forced labor with extremely low wages (*mitayos*) with paid labor (*mingas*). In the Toledo ordinances of 1574-1575, the daily wage of a *mitayo* was set at 3-4 reales per day (2-3 pesos a week). *Mingas* made a little more than 3 pesos a week early on. However, later in time, *mingas* saw their wages rise to 7-9 pesos per week by 1600, while *mitayo* wages remained the same (Barragán 2017:203). By the 18th century, the majority of mining laborers were paid wages, and the *mita* draft was all but discontinued (Cole 1985). By the end of the colonial period in 1812, the *mita* had all but disappeared (Tandeter 1993).

To supplement poor wages during the 17th and 18th century, the practice of *kajcheo* (mentioned previously) became very popular among mining and refining laborers in the Andes. The *Código Carolino* mining ordinances, written in 1786-1794 by Pedro Vicente Cañete, indicate that *kajcheo* increased in Potosí throughout the 18th century (Tandeter 1992:112). The manuscript includes over 1,000 separate reforms dealing with mine ownership, the *mita*, working conditions, and laborer payments. Many of the reforms were meant to curtail and control *kajcheo*.

Cañete proposed many ways to curtail *kajcheo* during the 18^{th} century. In Ordinances 9 and 10 of Book 3, Title 7 (*Trapicheros* and *Caccas*[11] of Potosí) he proposes to organize *k'ajchas* into six gangs, which would be split into two groups of three to work half of the silver vein (JCB, Codex SP 64, 263r-263v). Each group was to be led by a *capitán* or gang leader, who should be a Spaniard or *mestizo*, instead of an indigenous person. Each *capitán* would be in control of a large group of indigenous laborers, and only registered *k'ajchas* would be allowed to work in the gangs (Tandeter 1992:112). This measure was supposed to stop indigenous laborers from taking good quality silver from the mines to be refined at *trapiches*, which were likely to be owned by lower-status individuals who would refine *k'ajcha* silver.

To stop the refining of "stolen" silver, Ordinance 3, Book 3, Title 7, advised that *trapicheros* should not process ore with a value of over 12 marks without notifying the authorities:

> *Ordenanza 3: Que los trapicheros no compren ni muelan metales que pasen de doce marcos sin dar noticia al Superintendente de Potosí en la forma que se expresa.*
>
> *En excediendo de doce marcos la ley de los metales pacos y de treinta los negrillos que lleven los caccas [k'ajchas] a vender o beneficiar en los trapiches hacer están obligados sus dueños a tomar razón del nombre del vendedor, y de la mina de donde los hubiere sacado dando pronto aviso a la superintendente para los efectos que convengan al orden público de la minería de la pena impuesta para la ordenanza 4, titulo 13, libro 1 de este código (JCB, Codex SP 64, 262r).*
>
> Ordinance 3: That trapiche owners should not purchase or process silver ore that has a value of over twelve marks without first giving notice to the Superintendent of Potosí in the manner expressed.
>
> Normal silver ore (*pacos*) which exceeds twelve marks, and richer silver ore (*negrillos*) that exceeds thirty marks, which the *caccas* [*k'ajchas*] take to sell or refine in the trapiches, the owners of the trapiches are obligating to inquire of the name of the seller, and of the mine where he would have taken the ore, giving prompt notice to the superintendent for the purposes that are appropriate to the public order of the mining of the penalty imposed for ordinance 4, title 13, book 1 of this code (JCB, Codex SP 64, 262r. English translation my own).

[11] This is another spelling variation of the word *k'ajchas.*

In this proposed law, *trapiche* owners were obligated to notify authorities if rich, high-quality silver was brought to their refineries by *k'ajchas*, prompting authorities to inspect the mines where the rich ore was coming from. This reform was intended to curtail the "theft" of high-quality ores during the *kajcheo*, and to make sure both *k'ajchas* and mine owners were profiting equally from the silver production. These ordinances reveal the fine line that both indigenous laborers and *trapiche* owners walked throughout the colonial period. While opportunities for advancement became more prevalent in the 18th century, there were many other points of conflict that sought to limit the advancement for various marginalized groups.

2.8 Summary

This chapter summarized the historical context of silver refining in colonial Peru during the 16th – 18th centuries, highlighting changes to technological processes and operational chains of production. The chapter then focuses on the social and cultural impacts of silver refining, highlighting the complex nature of power, inequality, and agency within these spaces, especially as they evolved over time. I show how many different types of individuals, such as women, indigenous owners, and *mestizos*, were actively involved in silver refining by the 18th century.

In sum, this chapter argues that some colonial silver refineries, such as the unregulated *trapiches*, provided a more flexible space where rigid colonial social norms did not necessarily apply, and where agentive action was possible for some people. By the 18th century, the Andes, and the Puno Bay in particular, were solidly in a second phase of silver mining and refining, with fewer forced-labor (*mitayo*) workers, more wage laborers, and more movement of people and goods on a yearly calendar rotation. These factors made the silver refining industry more hospitable and desirable to marginalized laborers.

3.0 Environmental and Historical Setting

3.1 Introduction

This chapter provides an overview of the environment and historical setting of the Puno Bay of Peru. It provides a general overview of the environmental setting, with a focus on the geological landscape that has made mining an important industry in this area. Locations and names of important towns, sites, and mines discussed in this chapter can be found in Figure 3.1.

Overall, this chapter offers an overview of the prehispanic settlement in the Puno Bay, followed by a description of the colonial period following Spanish contact in 1532 AD. The focus of the chapter will be how silver mining and refining were part of Spanish tribute collections, the *encomienda* labor grant system, and resettlement (*reducción*).

Following the overview of Spanish rule in the Puno Bay, the chapter will describe the two important silver mining *asientos* (mining seats) in the Puno region: San Antonio de Esquilache and San Luis de Alba. The history of colonial silver mining and refining industry in the Puno Bay will be reviewed, in addition to the Laicacota ethnic conflict. Overall, the chapter traces how control of the silver mining industry in Puno changed over time. While the early years of colonial mining saw the control of mines and technology by only a few individuals, later periods showed more diffused mine ownership through the formation of companies that allowed more people to be directly involved. The ethnicity and identity of laborers at these mines also shifted through time, as did their statuses as free, forced, and enslaved laborers.

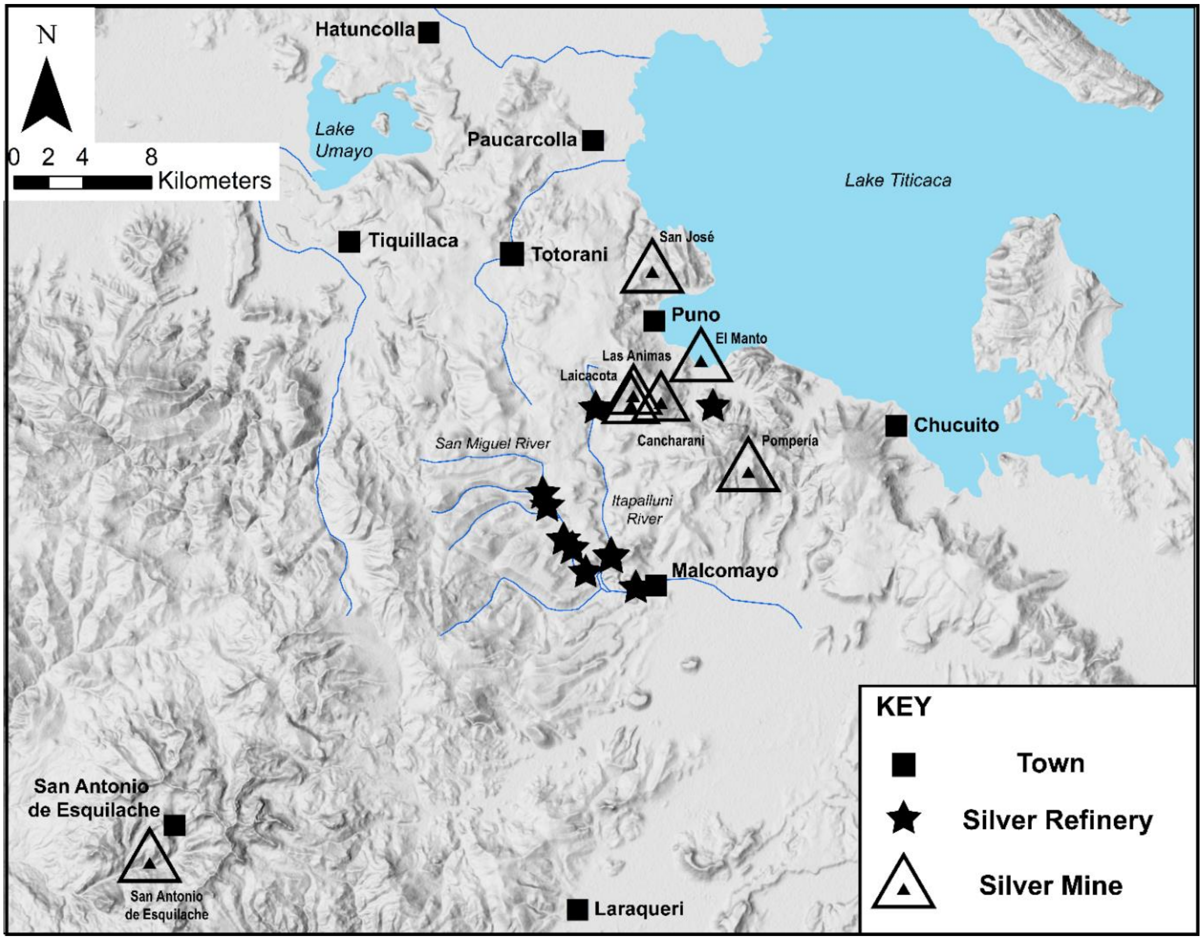

Figure 3.1: Regional map of the western Lake Titicaca Basin, with important silver mines and towns marked and labeled.

3.2 Environmental Setting

The present-day city of Puno is located on the Puno Bay, in the western Lake Titicaca Basin of southern Peru (Figure 3.2). The Puno Bay is located between the eastern and western Cordillera of the Andean Mountains. The waters of Lake Titicaca are thermoregulated, which mitigates issues of extreme cold and frost near the shores of the Lake, allowing for the planting of various types of agricultural crops right near the shore (Parodi Isolabella 1995:5-6).

Figure 3.2: Map of Peru with the city of Puno, as well as the study region, marked in the southern portion of the map.

While Lake Titicaca (Figure 3.3) provided nutrients for early human settlements through the abundance of plants and animals, as well as warmer shore temperatures, the climate surrounding Puno and the Puno Bay is marginal and extreme. Puno is a high-altitude city, sitting at 3,827 masl (12,556 ft), with just two seasons: rainy and dry. Nightly temperatures usually fall below freezing (0°C) (Figure 3.4), while during the day the sun can be quite intense. At least 8 to 9 months of the year can be characterized as cold or cool (Parodi Isolabella 1995:21). The area's climate is dependent on monsoons, which occur during the rainy season between December and March (Parodi Isolabella 1995:21). Roughly 70% of the annual rainfall for the Lake Titicaca Basin, ~758 mm/year, occurs during these four months (Roche et al. 1992; Schultze 2008).

Figure 3.3: View of Lake Titicaca from the Uros floating islands on a cloudy day in October 2018.

Figure 3.4 Snow fall at the Trapiche Itapalluni refinery south of Puno in July of 2018. 4,000 masl.

The climatic zone of the Puno area is defined as the *altiplano*, or high plains, where agriculture is risky due to cold temperatures, unpredictable rainfall, and soils lacking important nutrients (Erickson 1993, 2000; Stanish 2003). Frost resistant tubers were domesticated and cultivated in these areas, and long-term storage of tubers in the form of freeze-dried *chuño* was one early adaptative technique (Figure 3.5) (Bruno 2008; Hastorf 2008). Other agricultural adaptations include raised fields, terracing, and *cocha* water reservoirs (Erikson 2000).

The *altiplano* is well suited for animal pastoralism, and llama and alpaca (camelids) domestication and husbandry go back thousands of years in this region (Capriles and Tripcevich 2016; Moore 2016). Llama and alpacas were used for their meat, fiber, transportation, and dung (fuel) (Figure 3.6). Dried camelid meat, known as *ch'arki*, was another adaptive food preservation technique used in this area.

Figure 3.5 Freeze dried tubers at the local food market in Puno.

Figure 3.6: A herd of alpacas in the altiplano near San Antonio de Esquilache, Peru in August 2017. 5,000 masl.

Geologically, the Puno Bay sits within the Lake Titicaca central-volcanic zone, with volcanically active slab formation aiding in the production of silver and copper ores in the region. Puno, and the Andean region in general, sit along the Pacific Ridge where subduction of the Pacific Ocean crust under the continental crust causes metal-rich deposits like silver to form (Guerrero 2016). Local Puno geology includes Quaternary alluvium and Sillapaca and Tacaza volcanic formations, among others (Schultze 2008). Andesite rock is prevalent in the Puno Bay, as well as copper and silver. A geological map of the study region from Schultze 2008 and the Ministerio de Energía 1970 is redrawn in Figure 3.7, with locations of important Puno Bay mines and refineries also marked. Three of the four local silver mines fall within the Tacaza volcanic formation, while the silver refineries, located near water sources like rivers, are located on alluvial deposits. The geological zones on Figure 3.7 do not extend west or south in this map because data was not available from the source maps.

Modern mining reports from mines in the Puno Bay describe their formation from porphyry copper deposits (Schultze 2008:24-27; USGS 2020). Within these deposits are lead, zinc, silver, copper, and mercury (USGS 2020). Other ores and minerals include galena, sphalerite, barite, calcite, pyrite, and quartz. The modern reports state that silver from the Laicacota and Cancharani mines is found in galena deposits, likely argentiferous galena (PbS with Ag). While these reports come from the late 20th century, it is likely that the colonial ore deposits were also largely argentiferous galena.

The present-day city of Puno is the capital city of the larger Department of Puno (Figure 3.8). Surrounding the city of Puno are a series of hills (*cerros*), many of which were mined for silver during the 17th, 18th, and 19th centuries. Important mines in the region include El Calvario, Via Crucis, Azoguini, Huynaputina, and Huajspata (Parodi Isolabella 1995:19-20). Directly to the southwest of Puno, roughly 3-4 km from the central plaza, are the four most important silver mines for this dissertation project: Cerro Cancharani, Cerro Laicacota, Cerro Las Animas, and Cerro El Manto (Figure 3.9). Other nearby mines include Cerro San José and Cerro Pompería.

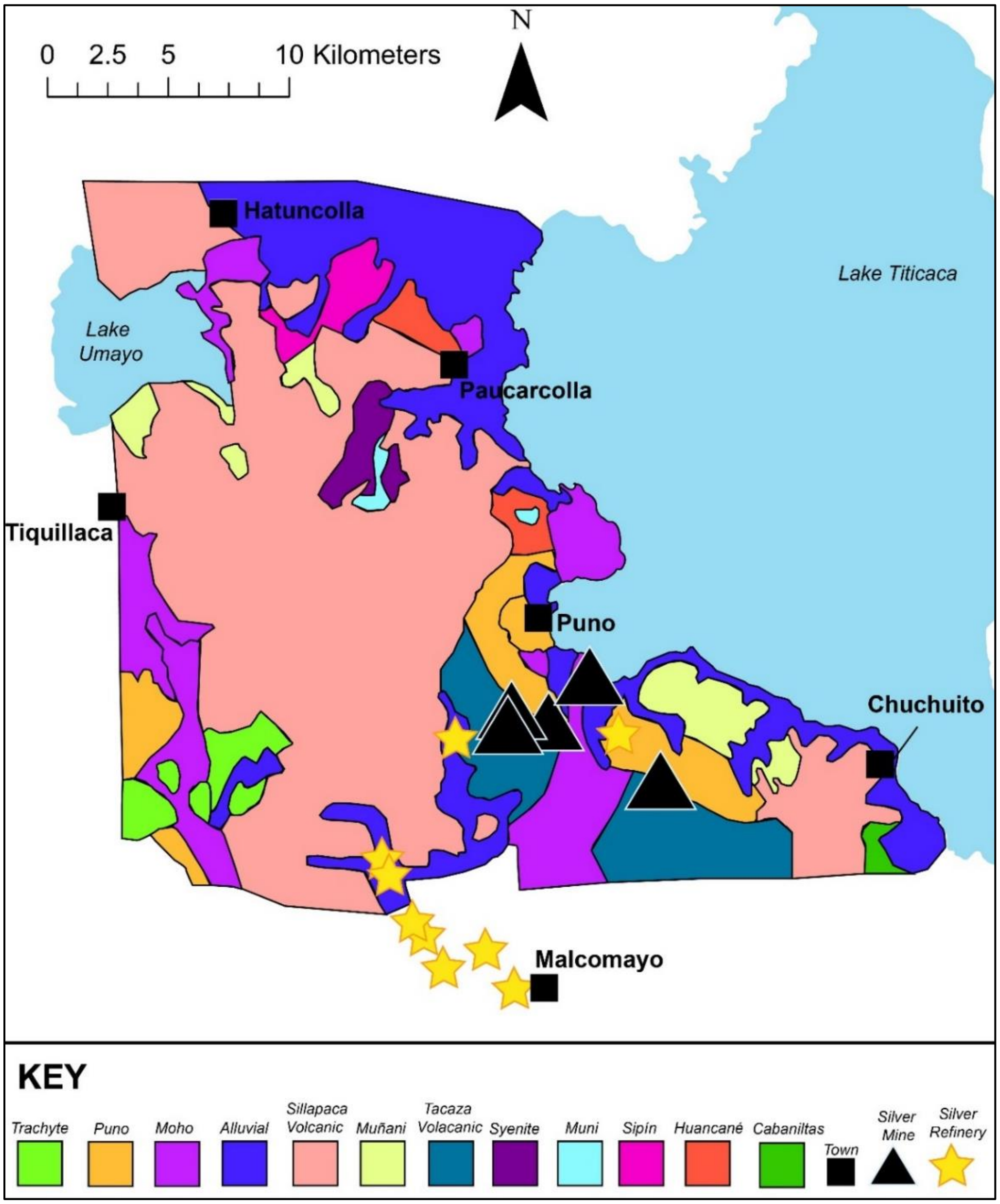

Figure 3.7: Geology of the Puno Bay. Redrawn from Schultze 2008:26.

Figure 3.8: A view of the city of Puno on the banks of Lake Titicaca and the Puno Bay. Photo taken from the Cerro Cancharani, located south of Puno, overlooking the city to the northeast. October 2018.

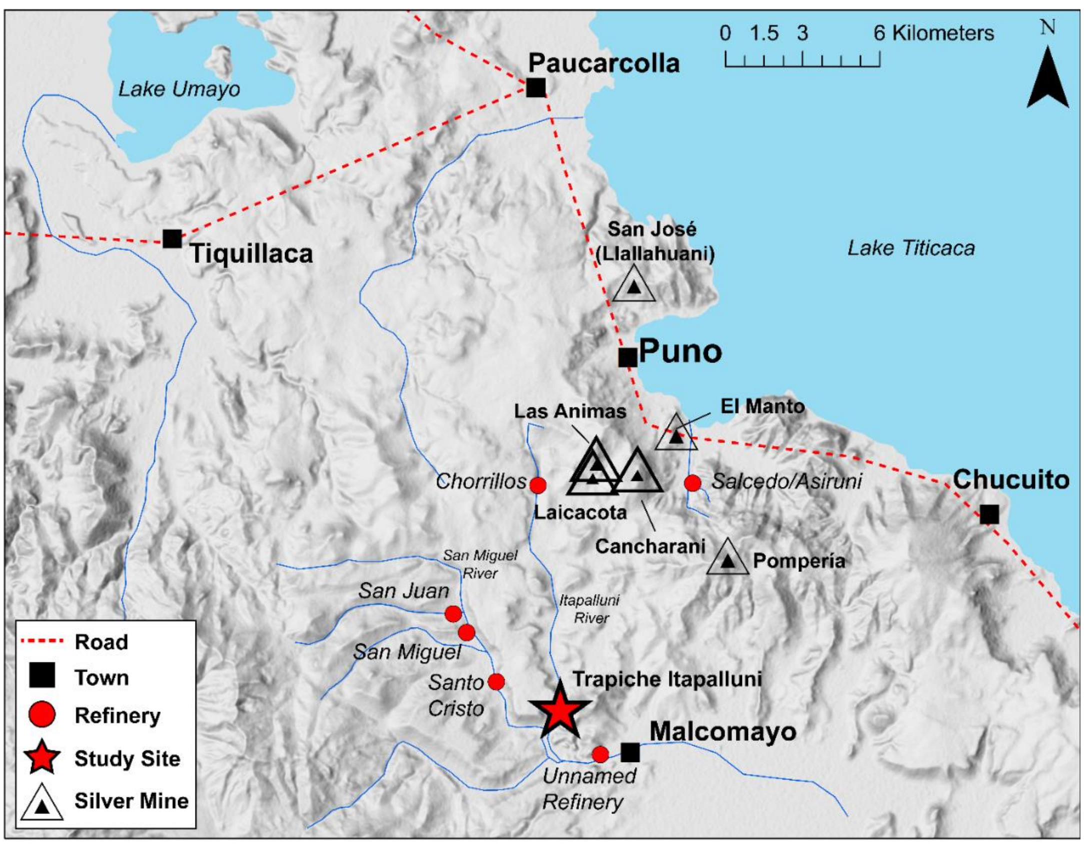

Figure 3.9: Colonial period silver mining and refining sites in the Puno Bay.

3.3 Prehispanic Settlement and Metallurgy

Human occupation of the Puno Bay in the western Lake Titicaca Basin includes a long history of prehispanic mining, quarrying, smelting, and refining (Schultze 2013). At the site of Jiskairumoko near Ilave, metal artifacts, such as hammered gold, date to the Late Archaic Period (3733 years BP) (Aldenderfer et al. 2008). At the site of Huajje near Puno, an early silver workshop was recorded with mineral debris that indicated complex ore reduction (~2000 years BP) (Schultze et al. 2009). Lake Titicaca sediment profiles containing lead deposits, a byproduct of silver production, indicate an increase in silver production in the area after 1000 AD, correlating to terminal stages of the Tiwanaku Empire, as well as Inka and early colonial periods (1400-1650 AD) (Abbot and Wolfe 2003; Cooke et al. 2008).

Earliest human activity in the Titicaca Basin were mobile hunter gatherers and has been dated to the Midden Archaic Period (8000-6700 BP) at the site of Soro Mik'aya Patjxa (Haas and Viviano Llave 2015). Sedentism occurred around 1500 BC in the region, corresponding with the development of small ceremonial centers, sunken enclosures, stepped platforms, anthropomorphic stone sculptures, and increased territoriality (Hastorf 2008). This period of settlement and increasing complexity took place during the Formative Period (1500 BC – 500 AD).

Toward the end of Upper Formative/Early Intermediate Period, around 500 AD, the centers of Pukara and the Taraco Peninsula became important sociopolitical regions in the area (Bandy 2004; Klarich 2005; Stanish 2003). Subsequently, the Tiwanaku Empire became the prominent sociopolitical entity in the region during the Middle Horizon Period (475-1100 AD). Following the collapse of the Tiwanaku Empire by 1000 AD, the Titicaca Basin saw a period of warfare, hillforts, and unrest, correlating with the rise of multiple Aymara *señorío* polities (ethno-political groups) during the Late Intermediate Period (1100-1450 AD) including the Collas, the Lupaqas, the Pacajes, and the Umasuyo (Arkush 2011; Stanish 2003). The two largest Aymara groups were the Collas and the Lupaqa, with their political and ethnic boundaries overlapped near this dissertation's study region just south of the Puno Bay.

The Late Horizon/Inka Period spanned a period of roughly a century in the Lake Titicaca Basin (1450-1540 AD). Spanish chroniclers Bernabé Cobo and Pedro de Cieza document the Inka conquest of the region in the mid-15th century, although scholars read these accounts with a critical eye, debating the degree of control the Inka truly had in the region (Stanish 2003:237). Many settlements believe to have been formed during Inka occupation may have been part of earlier Aymara settlements. However, Julien (1983) argues that most of the settlement increases in the Lake Titicaca Basin occurred during the Late Horizon, not before, when the Inka had active political control of the region. Julien's excavations at the site of Hatuncolla, which Spanish chroniclers Coba and Cieza describe as the capital of the Colla Kingdom, do not reveal occupation prior to the Inka control of the area (Julien 1983:107). Stanish (2003) argues that most of the Lake Titicaca Basin settlements identified and recorded during the colonial period were likely founded by the Inka along the Inka road and *tambo* system.

Early Spanish chroniclers such as Cobo, Garcilaso de la Vega, Guaman Pomo de Ayala, Juan de Betanzos, and Cieza de León describe the location of important Inka mines in southern Peru and western Bolivia (Hurtado Chávez 2008:10). The most important of these mining centers were Porco, Carabaya, Caylloma, and Cerro de Pasco (Cieza de León 1959 [1548]). The silver mine at Porco, located 800 km south of Puno, was described by Cieza de León as the main source of metal for the Inka Empire. Inka silver production also occurred closer to Puno, at San Antonio de Esquilache, which sits 60 km south of Puno (Schultze 2013). While the San Antonio de Esquilache silver mine has been attributed to the colonial period with its "discovery" in 1619 AD

(Domínguez 2017), Schultze (2013) argues it was used at least a century prior by the Inka, evidenced by a collection of Inka mine shafts and ceramics that Schultze identified at the site.

3.4 Spanish Rule in the Puno Bay

The Spanish conquest of the Inka took place between 1532-1533 AD, although a series of civil wars and infighting caused disruption and political unease for another decade (Covey 2020). However, Spanish control of the Lake Titicaca Basin did not occur until 1540 AD. Over the following two decades, the Spanish quickly became aware of the mineral potential of the Lake Titicaca region. This is evidenced in the 1567 *visita* (inspection) by Spaniard Garci Diez de San Miguel. Garci Diez states that one of his main objectives of the 1567 inspection was to interrogate the local indigenous *curacas* (chiefs) of each Lake Titicaca province to determine:

> *...sí tienen minas de oro o plata…y que distancia hay de los pueblos a las dichas minas…y la cantidad de indios se echan a la labor y en qué tiempo del ano (Garci Diez 2013 [1567]:26).*

> …if they had gold or silver mines…and how far the mines were from local towns…and how many indigenous laborers were needed to work each mine…and in what season of the year the mines could be worked (Garci Diez 2013 [1567]:26. English translation my own).

Garci Diez was interested not only in the location and presence of mines, but in their workability, as he questioned how many workers were needed and how far the mines were from towns and other strategic routes. Garci Diez asked these questions of all the *curacas*, although many of them chose not to answer. Their resistance to share their knowledge of silver and gold mines is evident throughout the *visita.* The *curacas* stated repeatedly that they did not have knowledge of local mines, emphasizing instead their wealth in livestock such as camelid and cattle herds. However, within Garci Diez's *visita*, we see the mention of many towns of *plateros* (silversmiths), and this occupation is frequently listed alongside farmers, potters, and fisherman as a common job in the area (Garci Diez 2013 [1567]:31, 35, 45, 47, 57, 74, 115). Noting this, the Spanish levied tribute on indigenous towns throughout the Lake Titicaca region, requesting large quantities of gold and silver as tribute (Garci Diez 2013 [1567]; Toledo 1975 [1572]).

Indigenous people living in the colonial town of Paucarcolla, located approximately 14 km north of Puno, are recorded in the Toledo Tasa of 1572 as paying tribute to the Spanish Crown in silver, animals, cloth, freeze-dried tubers (*chuño*), and fish (Cook 1975:59-60). The town of Paucarcolla was made up of both Aymara (711 taxpayers) and Uros (292 taxpayers) ethnic groups, and both were required to pay silver in tribute. The Uros were also taxed dried fish and salt (Cook et al. 1975:59-60). Both groups were taxed extra money to pay for "*la renta para la limosna de las minas"* (the continual rent and use of local mines in the area) (Cook et al. 1975:59).

The town of Puno is also mentioned in the Toledan Tasa of 1572 (Cook et al. 1975:54-55). The Toledo Tasa records state that, in the year 1573, Puno had 983 tribute-payers, and of these 653 were Aymara and 380 were Uros. There were 525 older individuals that no longer paid tribute, as well as 1,065 children aged 16 and younger, and 2,132 women of all ages and statuses. The total population of Puno was roughly 4,705 people in 1573 (Cook et al. 1975:54-55). Aymara individuals were assigned an annual tribute of 2,995 pesos of silver (5 pesos per person), as well as clothing, *chuño*, and 74 head of camelids (*carneros de la tierra*). These camelids (llamas or alpacas) were required to be adult animals, 2 ½ years old or older, and were likely used for transport and fiber by the Spanish (Cook et al. 1975:55). The Uros were required to pay 945 pesos in silver (2 ½ pesos per person), as well as *chuño*, dried fish, and clothing (Cook et al. 1975:55).

Of the silver tribute paid by the Aymara and Uros of Puno, 950 pesos were supposedly set aside for a religious priest to oversee the indoctrination of the local Puno population. The Toledan Tasa mentions that these priests were sent to both local towns *and* metallurgical zones such as silver mines and locations of "*beneficio*" or silver refining (Cook et al. 1975:55). While this was commonly stated in tribute and tax documents of the time, it did not always happen with regularity. We can assume that some Catholic priests were sent to Puno Bay silver mines and silver refineries during the late 16th century and early 17th century. However, they likely did not reside there full time, and instead would have visited infrequently.

While the Spaniards required tribute in the form of silver and gold in the Puno Bay, there was no specific push to initiate new mines in the area for nearly a century after the Spanish arrived in the Lake Titicaca Bain. The silver rush of Potosí to the south of Puno likely overshadowed the mineral potential of the Puno region for many years, as Potosí's height of silver production was from roughly 1550-1650 AD, peaking around the year 1620. During this period, many local Puno Bay tribute payers were conscripted and sent to the Potosí mines to work as *mitayos* (Garci Diez 2013 [1567]). A bust in silver production at Potosí occurred following the Great Potosí Mint Fraud of 1649, causing a decades-long loss in production and confidence in Potosí silver (Lane 2015, 2019). After peaking in the 1640s, Potosí's population began to decrease and never recovered.

Coincidently, silver production in the Lake Titicaca Basin took off in the 1650s, filling the void left by the silver bust at Potosí. Silver mines south of Puno at San Antonio de Esquilache were in operation before the Potosí bust, but the 1650s became their most successful period of silver production (Domínguez 2017:125). In addition to San Antonio de Esquilache, silver mines were discovered in the Puno Bay in 1657 (Brown 2012; Schultze 2013). The most productive of these mines, Laicacota, initiated a huge boom in silver production in the Puno Bay, and even surpassed the production of Potosí for a time (Cusi et al. 1992).

3.5 San Antonio de Esquilache

San Antonio de Esquilache was exploited for silver during prehispanic periods, as evidenced by Inka structures onsite (Schultze 2013). In 1619, Viceroy Conde de la Gomera "rediscovered" silver in the area and ordered the founding of a mining seat (*asiento minero*) at San Antonio de Esquilache (Figure 3.10). The *asiento* was named for the Viceroy of Peru at the time, Don Francisco de Borja y Aragon, Principe de Esquilache (Hurtado Chávez 2008:20).

By 1700, the owner of the mine, Captain Sebastían de Salazar and his wife, Doña Elena de Cadenas, had sold the mine to Salvador Saledón (CTAR 1999:9-10; Frisancho Pineda 1996). While the mine's height of silver production was between 1650-1750 AD, it continued to be exploited until the 1990s (over four centuries).

Figure 3.10: View of the San Antonio de Esquilache mines from the inside of a colonial structure within the adjacent town. Photo by author. 2017.

Adjacent to the silver mines at San Antonio de Esquilache were a series of silver refineries called the *Ribera de Arenado* (riverbank or shoreline of Arenado), near the present-day town of La Rioja (Figure 3.11) (Domínguez 2017). These silver refineries sat along a tributary river of the Tambo River and during its early operation, included at least four *ingenios* and one *trapiche* (Domínguez 2017). By 1651, a bishop from La Paz noted the presence of nine *ingenios* on the *Ribera*, as well as many indigenous laborers and a priest and clergy who provided mass for the Spanish and indigenous residents of the town (Figure 3.12) (Domínguez 2017).

In a later portion of this document, the bishop describes even more refineries present in the area by 1651, including six *ingenios*, three refineries, and some *trapiches* (unnumbered) (Domínguez 2017). Whatever the total count, we can assume there was between 5-15 silver refineries in operation at San Antonio de Esquilache by 1651, including a mix of *ingenios* and *trapiches.*

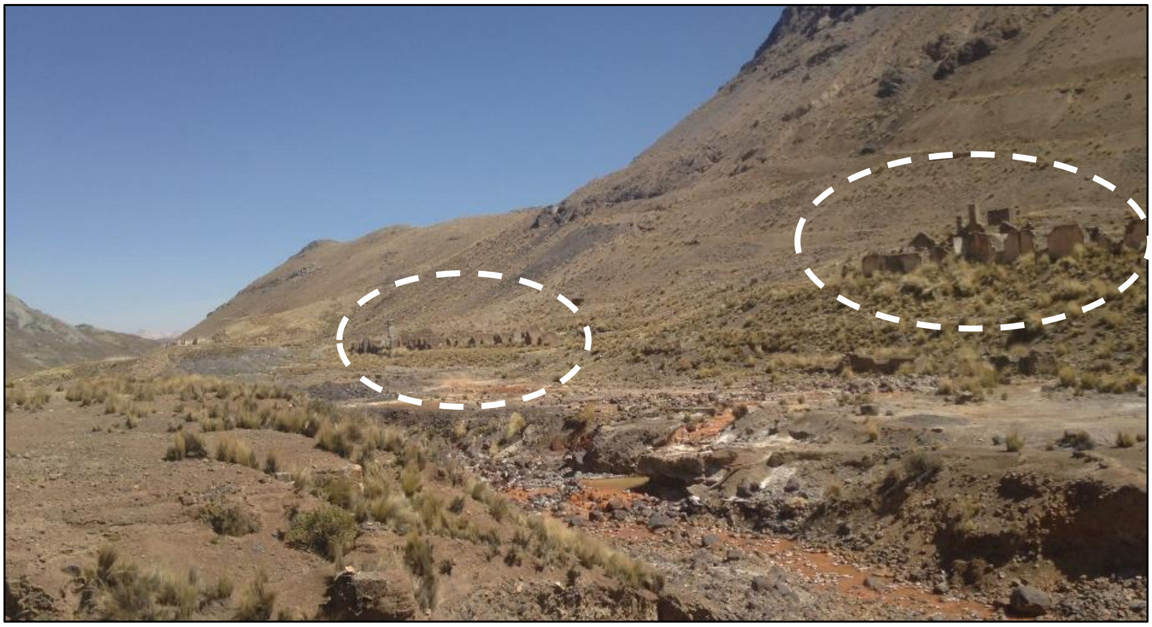

Figure 3.11: View of the river (stained orange) in the foreground, near San Antonio de Esquilache and the Ribera de Arenado. Remains of refineries marked in white circles. Photo by author. 2017.

Figure 3.12: The remains of the colonial church at San Antonio de Esquilache, with a cemetery located out of view.

Less is known about San Antonio de Esquilache in the 18th and 19th centuries (Domínguez 2017). There are descriptions of mine shaft flooding at San Antonio de Esquilache from 1753, a problem that was common in many mining centers in the Andes at the time. By the mid-18th century, many of the mine shafts were flooded and too risky to mine (Domínguez 2017:221). By 1779, reports document that San Antonio de Esquilache had already gone through a long period of inactivity, with the presence of local poverty, outward migration of workers, and the lack of church officials to give mass (Domínguez 2017:223). The San Antonio de Esquilache mines did experience a renewed era of activity in the 20th century, although it was zinc, not silver, that was mined in the area.

No other information is currently available on the development and history of the San Antonio de Esquilache mining center, and archaeological activity has yet to be initiated in this area. I visited San Antonio de Esquilache in August of 2017 as part of a reconnaissance I did for this dissertation project. I walked the site, conducted a brief surface survey, took photographs and notes of architecture, and used a drone to map the surface architecture of the site (Figures 3.13 and 3.14). The site itself was quite large and included a central church and church plaza, a cemetery, and one central road going north/south throughout the town. Nothing more has been done at the site to date. San Antonio de Esquilache is a prime location to test the evolution of Inka and prehispanic mining technology during colonial rule of the area, as it has a history of occupation well into the 20th century. It is also a prime location to look at miner lifeways through time.

Figure 3.13: Overlay of San Antonio de Esquilache drone map on google earth imagery of the region, showing area of drone map coverage.

Figure 3.14: Orthotiff map of San Antonio de Esquilache, produced from drone mapping and photogrammetry. Photos taken in August of 2017.

3.6 The Town of Puno

Prior to the "rediscovery" of silver at San Antonio de Esquilache in 1619, the town of Puno was already occupied and well-known in the region. As mentioned previously, indigenous taxpayers from Puno date back to reports from 1567 and 1573 (Garci Diez 2013 [1567] and Toledo 1975 [1572]). As early at 1535, Francisco Pizzaro divided up groups of indigenous people in the Puno Bay into *encomiendas*, with one such *encomienda* named "Puno e Ycho" (Domínguez 2017:213). By the 1570s, Puno and Icho had each become their own individual community under Spanish jurisdiction. Puno itself was likely a forcibly resettled town (*reducción*) of native peoples, corresponding to Francisco de Toledo's resettlement reforms from the 1570s. Referred to as a "*pueblo de indios"* or "Indian town," it was officially known as the *reducción de San Juan Bautista de Puno* by 1573 (Cosme Bueno 1951 [1770]:23).

Spanish chronicler Bernabé Cobo describes the *reducción* of Puno in 1635 during his journey from Cusco to the Lake Titicaca Basin. Cobo mentions Puno, as well as the nearby silver refining area of Itapalluni:

> *…Llegaba muy tortuoso por el actual alto de santa rosa, para dar la vuelta por Nuñua y de ahí a Ayaviri y Pucara, de donde se dirigía a Asillo y Arapa para regresar a Cabana y penetrar en Lampa. De ahí en camino recto iba a Xuliaca y recto también pasando por el oeste de Paurcarcolla llegaba a Umayo, de donde pasando por* ***Puñu y Tapalluni [Puno and Itapalluni]*** *bajaba por Cutimbo y Siruni hasta Chimu y Ojerana bordeando la laguna pasaba por Chucuito… (Cobo 1983 [1653]; cited in Hurtado Chávez 2008:3).*

> …I arrived by a very winding and tortuous route, passing through the top of Santa Rosa, around Nuñua and from there to Ayaviri and Pucara, from where I headed to Asillo and Arapa to return to Cabana, and then on to Lampa. From there I continued straight to Xuliaca and passed through the western portion of Paurcarcolla, where I arrived at Umayo, and from which I then passed through **Puñu and Tapalluni [Puno and Itapalluni],** heading down through Cutimbo and Siruni until Chimu and Ojerana bordering the lake by Chucuito… (Cobo 1983 [1653]; cited in Hurtado Chávez 2008:3. English translation and bolding my own).

By 1608, upon the creation of the bishopric of La Paz, "Puno" was listed as one of the parishes within the vicariate of Paucarcolla, along with nearby Chucuito, Huancane, Moho, and Icho (Hurtado Chávez 2006:20). In the early years of its occupation, the Puno *reducción* was located within the Audiencia de Charcas, on the border of the Corregimiento de Paurcarcolla and the Gobernación de Chucuito (Hurtado Chávez 2006:22). As noted previously, this was also the dividing line for the Aymara *señoríos* of the Colla and the Lupaqa, and Puno sits on the language divide for Quechua and Aymara.

After the founding of San Antonio de Esquilache and its creation as an *Asiento de Minas* in 1619, San Antonio de Esquilache became the commercial center of the entire Puno Bay region (Domínguez 2006; Hurtado Chávez 2006:20). This in turn made the location of the Puno *reducción* more relevant, and it became an important *tambo* (inn or way station) for travelers and commercial operations traveling to and from San Antonio de Esquilache. Further, Puno was well-situated along the longer colonial route between Cusco and Potosí, and between Arequipa and Potosí (Figure 3.15) (Hurtado Chávez 2006:20). *Pulperías* (stores and bodegas) tended to dominate these types of colonial *tambos* during this period, and they became important locations for trade and commerce. This was also true for the *pulperías* in Puno, especially during the silver booms at Potosí and San Antonio de Esquilache (Domínguez 2006).

Figure 3.15: Location of Puno along major colonial trade routes.

Many of the surrounding indigenous communities in the western Lake Titicaca Basin, such as Manazo, Vilque, and Tiquillaca, likely provided Puno's *pulperías* with meat during this period, as they were known to raise an abundance of cattle and were also listed as *marcamaya* communities (communities that provided supplies to *tambos*, plazas, and travelers) (Hurtado Chávez 2006:21). Many indigenous people from these communities moved to Puno during the 17th century to work as merchants in the *pulperías.* They took advantage of the silver booms to sell food products to travelers, merchants, and muleteers passing along the Inka road, now a bustling colonial highway. During the 1620s and 1630s, Puno grew in population and became an important and necessary stop along the way to the important mining centers to its south.

By the 1640s, the Puno *reducción* had been functioning as an important market and commercial stop for half a century. However, it had yet to see a growth in its own mining and metallurgical infrastructure. This changed in the 1640s and 1650s, when the bust at Potosí left a huge void in silver production. This, in turn, initiated a boom at San Antonio de Esquilache, with an influx of refinery construction along its *Ribera de Arenado* (Domínguez 2006, 2017). Space quickly became limited along the waterways near San Antonio de Esquilache. Water, as well as the position of one's refinery along the river (upriver had more power and control of the water system), became a highly desired resource. Many mine owners in San Antonio de Esquilache were forced to find peripheral areas to build their refineries to survive the increased competition (Domínguez 2006). They often had to look in areas very far from the San Antonio de Esquilache mine – such as Puno, 60 km away.

One of the first recorded silver refineries built in Puno belonged to Gaspar de Salcedo, who began construction on his San Antonio de Asiruni *ingenio* in 1654 near Puno (Hurtado Chávez 2006:29-30). Gaspar was a well-known Andalusian *minero* (mine owner and entrepreneur) and solider, and he served as Capitán General of the Paucarcolla Province starting in 1654, the same year he built his refinery. The ore he processed in his Puno Bay *ingenio* (see Chapter 4 for more detail) came from his silver mines at San Antonio de Esquilache, 60 km away, and Gaspar quickly became one of the earliest mining entrepreneurs in the Puno Bay (Hurtado Chávez 2006:29-30). Gaspar's mining success led to his own political success as well, as he was promoted to the Capitán General of San Antonio de Esquilache two years later, in 1656 (Parodi Isolabella 1995:55).

Gaspar de Salcedo and his brother, Joseph became important players in the subsequent development of the silvery mining industry in the Puno Bay. Both were born in Seville, Spain, in Andalusia (Joseph in 1611 and Gaspar in 1618) as the legitimate sons of Don Gaspar de Salcedo and Doña Maria de Landa y Gueuara (Testamento de Gaspar de Salcedo 1692, cited in Frisancho Pineda 1999:82). Not much is known about their lives in Spain. Joseph arrived in Peru around 1637, at the age of 26, and started working mining claims near Puno at the San José mines sometime in the 1640s and 1650s. As the younger son, Gaspar joined the *Armada Real Espanola* and came to South America as a solider. Joseph later convinced him to enter the mining industry. Gaspar ended up owning a variety of mining claims at San Antonio de Esquilache (Hurtado Chávez 2006:26-27; Parodi Isolabella 1995:54-55).

In 1657, Joseph, who had been working the San José mines close to Puno, "discovered" a silver mine south of Puno called Laicacota (see Chapter 1 for a more detailed discussion of this "discovery"). On May 1st, 1657, Joseph de Salcedo registered his ownership claim for the Laicacota mine, initiating the first real silver boom in the Puno Bay (Hurtado Chávez 2006:30). The original mining claim registered to Joseph was referred to as Laicacota la Alta (the upper), while Joseph's brother, Gaspar, controlled the additional silver veins of Laicacota la Baja (the lower) and Las Animas. Other subsequent mines were discovered in the area during the 1650s and 1660s, including Cancharani, Pompería, and El Manto (Hurtado Chávez 2006:36-37). This mining area became known as San Luis de Alba de Laicacota.

3.7 San Luis de Alba

Due to the boom in silver production in the 1650s and 1660s, the mining seat (*asiento*) of San Luis de Alba de Laicacota was formed near the banks of Cerro Negro Peque and Cerro

Cancharani (Figure 3.16). San Luis de Alba[12] was named after the Viceroy of Peru at the time, the Count of Alba de Liste, who was Viceroy from 1655-1661. This mining camp was well positioned in the saddle between two mountains, and it was also located near an old Inka road. The Inka road was a main route through the region, passing through Lampa and Tiquillaca before entering the Puno Bay from the north, until it arrived at San Luis de Alba. This is the same Inka road which passes by the silver refineries of Chorrillos and Trapiche Itapalluni (see more on these refineries in Chapter's 4-5) (Hurtado Chávez 2005:36-37).

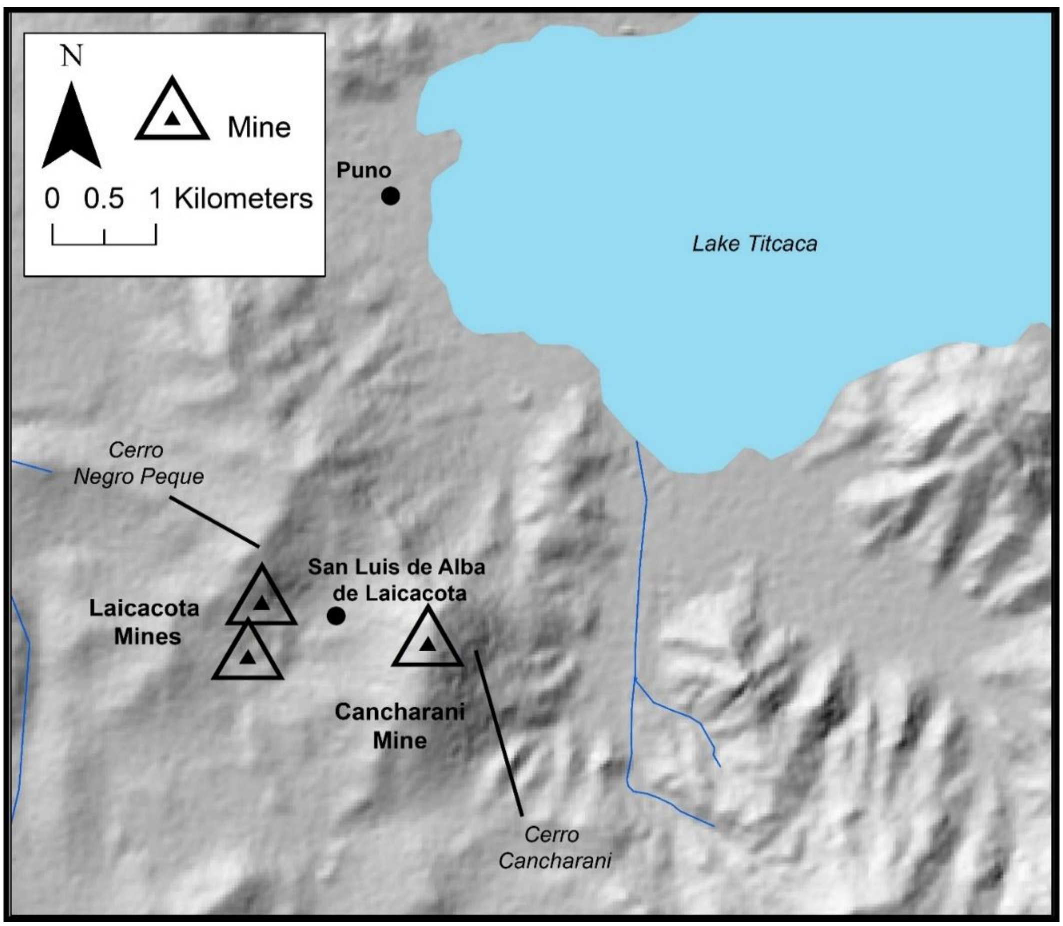

Figure 3.16: Location of the mining asiento of San Luis de Alba de Laicacota, in the saddle between Cerro Negro Peque and Cerro Cancharani.

[12] As noted in Chapter 1, San Luis de Alba de Laicacota is sometimes shortened to "Laicacota" in the historiography, but to avoid confusion, I will refer to the physical mine as Laicacota, and the adjacent mining camp as San Luis de Alba.

Around the year 1665, two years before the "discovery" of silver at the Laicacota mine, San Luis de Alba was given official ecclesiastical authority, including its own parish priest (Domínguez 2006:254). San Luis de Alba quickly grew into a large mining community, especially following the 1667 discovery of silver at Laicacota. Apparently Fray Pedro Gutierrez Flores sent a letter to the Viceroy at the time, discussing all the churches in San Luis de Alba (AGI, Sección II, Contaduria, Legajo 1878, p. 143). These documents, housed at the *Archivo General de Indias* (AGI), describe San Luis de Alba as having over 3,000 houses (Dodge 1984). However, historians have recently interpreted these documents as exaggerating the size and importance of San Luis de Alba during this period. Likely, these numbers refer to the larger Puno Bay region, which would have included various *reducciones,* instead of the individual structures within the San Luis de Alba mining camp itself (Parodi Isolabella 1995:56).

In her 1984 dissertation, historian Meredith Dodge uses testimonies against the Salcedo brothers from 1664 to describe the sprawling mining camp of San Luis de Alba. Dodge lists three churches in the camp: the Iglesia de San Francisco, the Capilla del Señor Obispo (also known as the Capilla de los Santos Lugares), and the Capilla de las Animas (Dodge 1984:77; EdC 564, cuad. 14, f. 40v AGI). There was a central plaza lined with large houses belonging to important mine owners, including the Basque don Alonso de Bellota and the Basque don Polo de Ondegardo, as well as the official *Corregidor* (Dodge 1984:77-78, ibid. AGI). There were no official town halls or government buildings at San Luis de Alba, as it was not an official town, only a mining seat.

The rest of the San Luis de Alba camp was not built on a grid pattern and scattered throughout the area were important houses belonging to Gaspar de Salcedo, Juan Antonio de Mestas, Alonso de Mesa, Juan Pacheco de Carmona, Francisco de España, and Marcos de Villafranca, many of whom were Andaluces. Many of the houses were also used as *pulperías* and stores, including a store owned by Gaspar de Salcedo, as well as one owned by Doña Maria Panyagua (Dodge 1984:77-78; ibid. AGI).

What we know about the ethnic backgrounds of the residents of San Luis de Alba comes from work by Dodge (1984) and Domínguez (2006). San Luis de Alba differed from Puno at this time, as Puno was a *reducción de indios* and most of its occupants were indigenous Aymara and Uros. San Luis de Alba was more ethnically diverse, inhabited by a collection of mostly Basque and Andalusian Spaniards, as well as a mix of Europeans, *mestizos*, enslaved Africans, and indigenous peoples. As early as 1643, an enslaved, 16-year-old Angolan named Antonio was purchased and transported from Potosí to San Luis de Alba by Bernadro Enríquez Camargo, who was listed as a mine owner on Laicacota (ABNB ALP MIN 146/17:58v).

In addition to mine owners and people hoping to get rich on the silver deposits, many people living at San Luis de Alba were merchants, store owners, and traders. Indigenous and *mestizo aviadores* (money lenders) often passed through the mining camp, supplying the camp with money, goods, and supplies. Some wealthy merchants loaned out ready cash to mine laborers or collected debts.

Labor at the mines within the San Luis de Alba mining district was initially different than that at Potosí and other larger silver mining centers. This was because many indigenous people in the local *reducciones* were drafted as *mitayos* labor workers to Potosí. However, there is no evidence that a large-scale *mita* labor draft occurred at San Luis de Alba. Instead, it is likely that laborers included a mix of enslaved Africans, Spanish and European overseers and guards, and a mix of *mestizo*, indigenous, and poor European miners and refinery laborers.

3.8 Puno Bay Silver Mines

In addition to the Laicacota silver mine, which included the veins of Laicacota la Alta Laicacota la Baja, and Las Animas, there were numerous other mines in the Puno Bay region. The Laicacota mines themselves were located on Cerro Negro Peque. They were exploited from the 16th century until the 18th century and some of the documented Laicacota mine owners are depicted in Table 3.1 (CTAR 1999:8-9; Frisancho Pineda 1996). The hill directly to the east of the Laicacota mines is Cerro Cancharani. It has been exploited from the end of the 17th century until the 19th century and known owners are depicted in Table 3.2 (CTAR 1999:8; Frisancho Pineda 1996).

Table 3.1: List of Documented Mine Owners at Laicacota.

Time Period	Owner 1	Owner 2	Owner 3
1657-1668	Joseph de Salcedo		
1668	Gaspar de Salcedo		
1700	Sebastián Gonzales de la Fuente;	Marcos García de Arriaga	
1707	Tiburcio y Felipe Ramírez de Ayala;	Claudio Mosquera	
1708	Pedro Bentura Dávila	Blas Bentura Dávila	Bentura Dávila
1727	Doña Micaela de Andraca Munive (widow of Gaspar de Salcedo)		
1733	Juan Antonio de Oreytia		

Table 3.2: List of Documented Mine Owners at Cancharani.

Time Period	Owner 1	Owner 2	Owner 3
1700	Pedro Martín de Vargas	José Duran	
1701	Jacinto Gómez	Francisco de Vera	Francisco Martínez de Arazola
1725	Rosa de Zanconeto, widow of Manuel Tenaquero		
1741	Mateo de Sea	Miguel de San Romano y Zevallos	

Additionally, a mine located in a nearby region was called El Manto. This mine was exploited from the middle of the 17th century to the middle of the 19th century (Table 3.3; CTAR 1999:8; Frisancho Pineda 1996). Another mine located south of San Luis de Alba was called Pompería, sometimes referred to as "Ponperia." It was discovered in 1700 and worked throughout the 19th century (Table 3.4) (CTAR 1999:9; Frisancho Pineda 1996).

Table 3.3: List of Documented Mine Owners at El Manto.

Time Period	Owner 1	Owner 2	Owner 3
1700	Juan Freyre de Andrade	Juan de Oreytia	
1729	Cristóbal de Galdo Arellano	José Jáuregui	
Post 1730	Juana Rosas	Claudio Mosquera	Doña Brígida de Ayala

Table 3.4: List of Documented Mine Owners at Pompería.

Time Period	Owner 1	Owner 2	Owner 3
1700	Capitan Freyre de Andrade	José Duran	Gerónimo Aguayo
1706	Juan de Oreytia		
1707	José Salcedo Márquez de Villa Rica, son of Joseph de Salcedo		
1709	Marcos de Valverde		
1717	Juan de Murga Villavicencio		
1724	Micaela de Andraca, widow of Gaspar de Salcedo	José Gonzales de San Román	
1731	Mateo Ortega		
1741	Juan Antonio Bravo de Saravia		
1835	Blas Bravo in 1835		

3.9 The Laicacota Conflict

While there were many Puno Bay silver mines exploited during the colonial period, the most infamous mine was Laicacota, because of the decades-long fight over its control. This period, called the Laicacota conflict (sometimes the Laicacota Rebellion), saw civil unrest in the Puno Bay between the years of 1657 and 1670. Detailed in works by Domínguez (2006; 2019) and Dodge (1984), this was a period of ethnic conflict that started as infighting between Spanish Basque and Andalusian factions in the Lake Titicaca Basin. It later broadened to include a newly emerging middle class of *mestizos* who fought alongside the Basques. Gaspar and Joseph de Salcedo, being from Andalucía, were major leaders of the Adaluz group and were positioned against the Basque/*mestizo* group. The Salcedos spent much of the 1660s fighting for control over their Puno Bay mines and refineries, sometimes fleeing Puno to hide at their refineries in San Antonio de Esquilache for protection (Parodi Isolabella 1995:57).

The Laicacota conflict reached a tipping point in 1668, when the Viceroy of Peru at the time, Pedro Antonio Fernandez de Castro, Conde de Lemos, called Gaspar de Salcedo to Lima to interrogate him about the ongoing conflict. Gaspar was then detained and jailed. Later, the Conde de Lemos traveled to the Laicacota mine and arrived in San Luis de Alba on August 3, 1668. He immediately set up a *Tribunal* (court) to try the participants of the conflict. The Conde de Lemos sided with the Basque and *mestizo* faction and laid most of the charges against the Salcedo brothers (Parodi Isolabella 1995:58-59). The Salcedos were accused of being the sole aggressors and responsible parties for the ongoing conflict, disturbances, and deaths over the control of mining in the Puno Bay. The brothers were also accused of raising a civilian army against the Viceroy and building a fort within one of their silver refineries. The Salcedos were also accused of infrequently working their mines and refineries – a charge just as serious as starting a violent insurrection

(Parodi Isolabella 1995:60-61). Infrequently working colonial mines was seen as deliberately withholding profits for the Spanish crown, as all metals were subject to the royal fifth (*quinto real*), a colonial tax.

Joseph de Salcedo was sentenced to a public execution, and while he is said to have offered the Conde de Lemos a bribe of over 100,000 *reales* per day to wait for an appeal to the Crown, he was garroted on October 12th of 1668 (Basadre 1945; Parodi Isolabella 1995:61). To finalize the sentence, the Conde de Lemos supposedly burned down San Luis de Alba and ordered that the ground and surrounding area be strewn with salt. The Conde de Lemos forced the entire population of San Luis de Alba to move to the *reducción* of Puno, ending full-time settlement at San Luis de Alba (Parodi Isolabella 1995:61). Upon the destruction of San Luis de Alba and the influx of inhabitants into Puno, the Puno *reducción* was converted into an official Spanish settlement, renamed the “Villa de la Concepcion y San Carlos de Puno” in 1668 (Domínguez 2017:204).

Gaspar de Salcedo, still in jail in Lima, appealed his sentence in 1668. Gaspar argued that the judge in charge of the case was a known enemy of the Salcedo brothers, and that the witnesses in the trial were threatened into false testimony. Gaspar had to wait three years, but the charges against him were finally dropped on September 23rd, 1671 and he was set free. However, it took ten years for Gaspar to regain his mining and property rights. A full twenty-five years after his arrest, on November 13th, 1703, King Felipe V of Spain gave the title of “Marques de Villa Rica de Salcedo” to José de Salcedo, the son of the deceased Joseph de Salcedo, as retribution for the injustices caused against the Salcedo family (Parodi Isolabella 1995:62-63).

In 1668, after Gaspar’s arrest and Joseph’s death, silver production slowed to a halt at Laicacota. During the arrests and trials of 1668, the mines were not properly drained and began to fill with water (Cañete y Dominguez 1952 [1791]:650; Galaor et al. 1998:134). A year later, in

1669, the Conde de Lemos entrusted Antonio López de Quiroga, a famous mine owner from Potosí, with rehabilitating the Laicacota mines (Galaor et al. 1998:134). Three years later, in 1672, López de Quiroga purchased additional mines in the area for the price of 500 pesos (Galaor et al. 1998:134). López de Quiroga continued to work the Laicacota mines for almost two decades with little luck. By 1689, he complained that he had invested over 70,000 pesos of his own money into Puno Bay mines with nothing to show for it (Bakewell 1988:72-73).

When Gaspar de Salcedo finally returned to the Laicacota mines in the 1690s, he found them semi-flooded and abandoned by López de Quiroga. Despite attempts to clear the mine, there was so much water left in the mines that even the strongest efforts could not make the mine productive. Many locals attributed the ruin of the Laicacota mines as God's punishment for the Laicacota conflict (Cañete and Dominguez 1952 [1791]:650).

3.10 Second Boom at Cancharani

Following the Laicacota conflict, there was a period of relative inactivity in silver mining in the Puno Bay until a resurgence occurred in the 18th century at Cerro Cancharani (Galaor et al. 1998:134-135). Much of the mining resurgence was because of efforts by Miguel de San Román y Zevallos, who focused his effort on the hill adjacent to Laicacota, Cancharani. In addition to San Román y Zevallos, documents from this period reveal a series of mining entrepreneurs and mining companies whose collective efforts brought about a second silver mining boom to the Puno Bay.

By the 1740's, it was more common for mining companies to own mines and mining veins collectively, instead of one single owner. For example, in 1744, San Román y Zevallos formed a mining company alongside don Pedro de Villar y Zubiaur, of Lima, don José García Infanzón, of

Huamanga, and don Juan Antonio Brava de Saravia, of Puno, to exploit the mining veins on Cancharani (Galaor et al. 1998:141-142). These *mineros* (mine owners) likely had connections with the vice regal government, as they were granted 46 *mitayos* to work in their mines and refineries at Cancharani (Galaor et al. 1998:141). These workers were drafted from nearby Lake Titicaca towns of Huancane, Vilque, Pucara, and Angara and had actually been sent to work at the mines of Aporoma, in Carabaya, until the new mining boom at Cancharani increased labor demands near Puno (Galaor et al 1998:134-135; 141).

This mining boom made San Román y Zevallos the wealthiest and most successful mine owner of 18th century Puno (Antonio de Alcedo 1967 [1786]:251). The chronicler, Alonso Carrió de la Vandero, another fellow Asturian, described San Román y Zevallos in his 1773 work, *Lazarillo de Ciegos Caminantes*:

> *La villa [de Puno] … hubiera excedido en doce años a Potosí se no se hubiera aguado la gran mina de la compañía y descaecido el trabajo con la muerte del magnánimo asturiano San Román. Hubo ocasión que este administrador y principal compañero, falto de moneda sella, envió a Arequipa sesenta barras de plata, que valían más de 130,000 pesos, para que le enviasen 60,000, de modo adelantado el dinero, y en aquella ocasión, al que tenía mil pesos en moneda sellada, la daban una barra que importaba más de dos, a pagar el resto cuando vendiese o cobrase, y así pudo juntar don Lorenzo Oyanguren los 60,000 pesos que le pidió San Román en plata sellada. Este gran hombre en su línea, y a fuese por su fortuna o por su talento, saco en su tiempo tanta copia de metales que, además de pagar sus suertes, a los compañeros les dio a más de 50,000 pesos a cada uno. Dejo las canchas llenas de poderosos metales, para que se aprovechasen de ellos en el caso de una escasez u obras precisas para los desagües, y dejo una magnifica iglesia de cantería labrada para que sirviese de parroquia, hasta la última cornisa, con lo que fue Dios servido acabase sus días este buen hombre, que todavía llora aquella villa. Desde la muerte de este fue cayendo la mina hasta que se disolvió la compañía, por falta de fondos (Carrió de la Vandera 1985[1773]:135-136.)*

> The town [of Puno] would have exceeded Potosí in twelve years had not the mining company's great mine [Cancharani] been flooded and the work discarded upon the death of the magnanimous Asturian San Román. There was once an occasion, that [San Román], the administrator and main partner in the company, lacking hard cash and currency, sent sixty solid bars of silver to Arequipa, worth more than 130,000 pesos, for a cash advance of 60,000 pesos, and on that occasion, where he had a thousand pesos in sealed currency, he was given a bar worth double, to pay the rest when it was sold or collected, and thus

> Don Lorenazo Oyanguren could collect the 60,000 pesos that San Román had requested in sealed silver. This great man of his line, whether for his fortune or his talent, took out such a large amount of silver in his time that, in addition to paying off his debts and expenses, he gave each of his colleagues more than 50,000 pesos. He also left the area full of unmined silver, so that they could take advantage of the ore in times of shortage or flooding, and he also left a magnificent church of carved stonework to serve as a parish, until his last precipice, which God ordained, this good man's service was ended, for who the town still mourns. Since his death, the mine had been falling into disarray, and the mining company was dissolved, due to lack of funds (Carrió de la Vandera 1985[1773]:135-13. English translation my own).

In this passage, Carrió de la Vandero describes San Román y Zevallos as a heroic figure, leading the silver mining industry, as well as helping his colleagues and countrymen who were in need. San Román's death is noted as the primary reason why the Cancharani mines failed, while mine flooding is only casually mentioned. San Román is also described as leaving the area full of unmined silver for future mining entrepreneurs. In truth, San Román owned the mines together with other individuals as part of a mining company, and the bust in Puno mining operations had more to do with the inability to extract water from the mine shafts than anything else. This problem was not fully addressed until the 20th century.

3.11 19th Century Decline and Bust

Puno's problem with mine flooding continued into the 19th century, as modern pump technology was not yet available to alleviate these issues. However, this did not stop European mining companies from traveling to the region and recording the potential for future operations in Puno. In 1789, the German Zacharias Helms traveled to Puno and noted in his diary that all the mines surrounding Puno were flooded (Helms 1789:139-140). Two years later, in 1791, Pedro

Vicente Cañete y Domínguez (1952 [1791]:650-651) wrote hopefully that modern forms of mining technology would improve Puno's drainage issues.

According to certified accounts by public treasury administrators Jose Victoriano de la Riva and Mariano Luna in 1826, Cerro Cancharani was depleted to only three active mine shafts, with a total of only 66 workers (Rivero y Ustáriz 1857:33). Various English mining companies surveyed the Puno area in the early half of the 19th century for potential silver production and lamented the lack of more sustained mining efforts in the region (Rivero y Ustáriz 1857; Temple 1830).

In the 1840s, the French naturalist and explorer Francis de Laporte de Castelnau traveled through Puno and noted more than 200 abandoned mine shaft openings on Cerro Cancharani and noted only 30 indigenous workers performing mine labor tasks in the region. Upon interviewing the mine workers, Castelnau learned that the *barreteros* (pick men) worked 12-hour days, making 5 reales/day, or about 2 ½ to 3 pesos/week. The *apires* (ore sorters) made slightly less, at 4 reales/day. Castelnau estimated the daily production of silver at Cancharani during this time was about 6-8 *quintales* (600-800 lbs.) (Castelnau 1850-51, III:407-413; Galaor et al 1998:138).

By the 1870s, the silver mining industry in Puno had basically come to an end. Geographer and explorer Antonio Raimondi, along with archaeologist Ephraim George Squier, passed through Puno during this period and recorded the declining mining industry in the region (Galaor et al 1998:138). While Squier goes into great detail about the mythical stories surrounding Laicacota's discovery in the 1660s (Squier 1877:355-356), he also comments on the mining efforts, stating "the only mining operations at present consist in extracting the silver from the rejected ores of former days" (Squier 1877:356).

3.12 Summary

This chapter provided an overview of the environment and historical background of Puno, Peru. Included in the summary was a discussion of the prehispanic mining and settlement in the region, focusing on silver mining and refining. In the discussion of Spanish rule in the Puno Bay this chapter covers tribute, the *encomienda*, and the *reducción*, as well as mita labor drafts that sent men from the Puno Bay south to Potosí to labor in the silver mines. Mining efforts at San Antonio de Esquilache, Puno, and San Luis de Alba are also discussed.

Throughout this chapter, the nature of identity and ethnicity among workers, laborers, mine overseers, and mine owners is highlighted. Throughout the 16th and 17th centuries, the region became an important mining center, as well as a key location along various colonial roads in and out of the region. These characteristics drew many opportunists of various backgrounds to the Puno Bay to benefit from this boom. Apart from working in silver mines and refineries, there were also opportunities to work as general laborers, muleteers, money lenders, tradesmen, cooks, and/or store owners.

While the 16th century mining boom of Potosí to the south of Puno used forced and enslaved labor from indigenous Andean and African miners and refiners, the Puno Bay did not itself have a documented labor draft for its 1660 and 1740 silver booms. While some laborers did come to Puno against their will during the colonial period, like 16-year-old Antonio sold into slavery, or the 46 *mitayos* sent to work at Cancharani, the majority of the workers in the silver mines and refineries appear to have been voluntary workers. This means that Puno functioned differently than Potosí and other large, urban silver mining centers in the Americas during this time. Its relatively small silver deposits, combined with their late "discovery" well into the 17th

century, likely contributed to a more open labor market, as wages and payment for labor became more common throughout the 17th and 18th centuries.

This chapter has also detailed changes in Puno mine ownership and control throughout the 17th and 18th centuries. While the early years of colonial silver mining saw the control of mines by a few Spanish men born, later periods show a sharing of control between multiple owners. By the mid-18th century, many mining veins were owned by a collection of interested parties within mining companies. Some company members were even women and *mestizos*.

4.0 Silver Refineries of the Puno Bay

4.1 Introduction

The first three chapters of this dissertation have situated my research questions into the larger body of scholarship on Andean mining, silver refining, labor, and identity. This chapter, Chapter 4, is much more narrowly focused on primary data collected from silver refineries in the Puno Bay. This includes architectural data from the sites of San Juan, San Miguel, Santo Cristo, Chorrillos Itapalluni, and Trapiche Itapalluni.

Following the overview of mapping and architecture data, this chapter presents archival data related to these refineries. This data comes from the Archivo Regional de Puno (ARP) in Puno, Peru, the Archivo y Biblioteca Nacionales de Bolivia (ABNB) in Sucre, Bolivia, and the John Carter Brown Library (JCB) and the John Hay Library (JHL), both located at Brown University in Providence, RI. I draw on a variety of archival sources from these archives to identify the location, names, and owners of the Puno Bay silver refineries.

The end of this chapter I "connect the dots" between the architectural data and the archival data and reveal how silver refineries changed throughout the colonial period in the Puno Bay. Similar to what was presented in Chapter 3, total control of the production chain by one or two powerful individuals breaks down and becomes less integrated by the mid-18th century. This is visible in changes in ownership of the silver refineries, as well as disputes over refinery ownership throughout the 18th century.

4.2 Site Reconnaissance and Drone Mapping

Colonial-era silver refineries discussed in this chapter were first located and recorded during the summer of 2017 as part of my pilot study centered on identifying 17th and 18th century silver mining sites and refineries in the Puno Bay. During the pilot study, a limited reconnaissance of the Itapalluni River and San Miguel River systems was conducted, and eight colonial refineries were identified. One of these was Trapiche Itapalluni, where we ended up excavating (see Chapter 7) (Figure 4.1).

Reconnaissance included walking both the Itapalluni and San Miguel River drainages in teams of 3-4 individuals on separate days, spread out in 10-20 m transects. Each reconnaissance transect worked from north to south (Chorrillos to "Unnamed Mill" for the Itapalluni River; San Juan to Jancalayo for the San Miguel River) and took an average of 5-6 hours to complete. Of the eight identified refineries identified, the site of Chorrillos was already well-known in the region and is still sometimes erroneously referred to as the mining settlement of San Luis de Alba[13] (Domínguez 2006; Nuñez 2001).

Following the initial location and recording of the eight Itapalluni/San Miguel silver refineries with global positioning units (GPS), we used unmanned aerial vehicles (UAVs, or "drones") to produce highly detailed base maps of these sites. The UAVs were used to gather digital imagery at various scales and precision, which allowed for the detailed mapping and 3-D modeling (what is referred to as photogrammetry) of architecture and above-ground features.

[13] See Chapter 3 for more information about the colonial mining camp of San Luis de Alba.

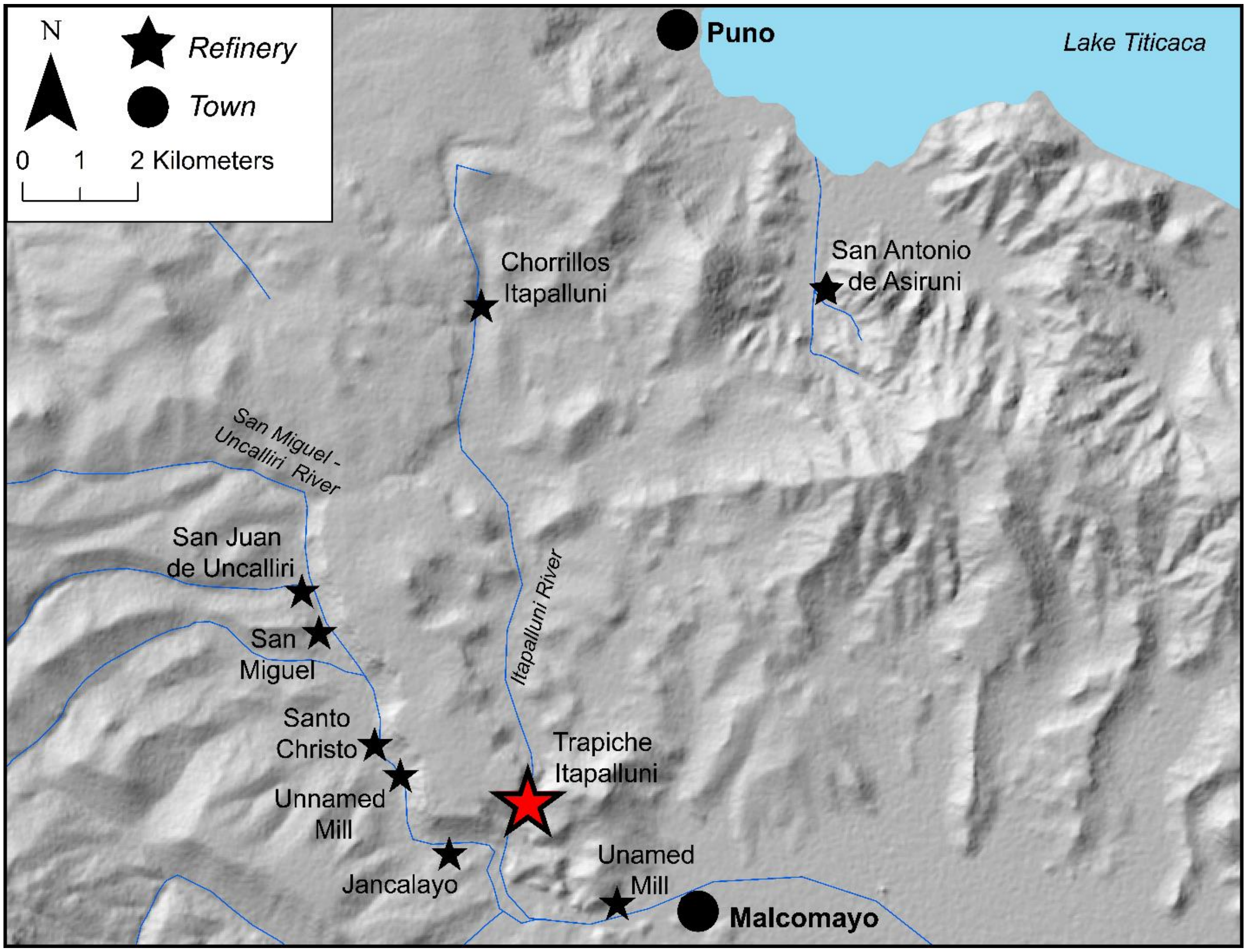

Figure 4.1: Map of the Puno Bay, depicting colonial silver refineries identified and mapped by this project in 2017 and 2018 as black starts. Excavations eventually took place at Trapiche Itapalluni, marked by a red star on this map.

Two different UAVs were used to map these sites, based simply on the availability of equipment. In the initial pilot study conducted in 2017, we used a DJI Mavic Pro to map Trapiche and a DJI Phantom 3 Standard to map the five additional mining and refining sites (Figures 4.2 and 4.3). In the 2018 field season, we only used the DJI Phantom 3 Standard, mapping further portions of the extended Trapiche site area. While the Mavic Pro was newer and more expensive than the Phantom 3 Standard, both models were compatible with mapping and photogrammetry software, and both gave satisfactory results.

Figure 4.2: Sarah Kennedy with a DJI Phantom 3 drone.

Figure 4.3: Ryan Smith flies a DJI Mavic Pro drone.

During the 2017 and 2018 drone mapping, both models of UAV experienced challenges to their functionality in the cold, high-altitude conditions of the Lake Titicaca Basin. The high altitude of the sites (at or above 4,000 masl) dramatically decreased battery life. Additionally, because all the sites mapped for this dissertation were directly associated with silver mining and refining, high levels of heavy metals in the soils appeared to affect the UAV's positioning. Multiple warnings of high magnetic interference interfered with the controller's signal to the UAV during flight. Due to this interference, all drone mapping had to be conducted in manual flight mode, as the use of any automated, preprogrammed flight plan software was unsuccessful (see Smith and Kennedy 2018 for the pros and cons of using automated flight plans for UAVs).

Manual flight of the UAVs consisted of flying at an average of 30 m above the ground in linear strips or transects. The UAV camera was positioned vertically down in the "nadir" position, and photographs were taken at an average of one photo every 10 m. Each photograph had approximately 50% overlap with the prior photograph, although because the UAVs were flown manually, this overlap varied for each flight. Overlap was important for the subsequent photogrammetry process, as the photographs are stitched together through a recognition of repetitive pixel colors between photographs.

Following the field mapping with the UAVs, I imported the photographs from each site into AgiSoft Photoscan photogrammetry software. Through a series of steps within this program, the photographs were aligned to create a 3-D model of each site (Figure 4.4). The models were exported as both 3-D digital elevation models (DEMs) and orthomosaic TIFF images. The DEMs and orthomosaics were imported to ArcGIS for use in subsequent spatial analysis (Figure 4.5).

UTM coordinates from all sites were also uploaded into the GIS, as well as vector maps of regional rivers and lake systems obtained from the Peruvian government. The regional ASTER DEM includes 30 m resolution and was obtained from NASA's Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model.

Figure 4.4: Orthotiff drone map of the Chorrillos refinery, overlaid on a Google Earth background.

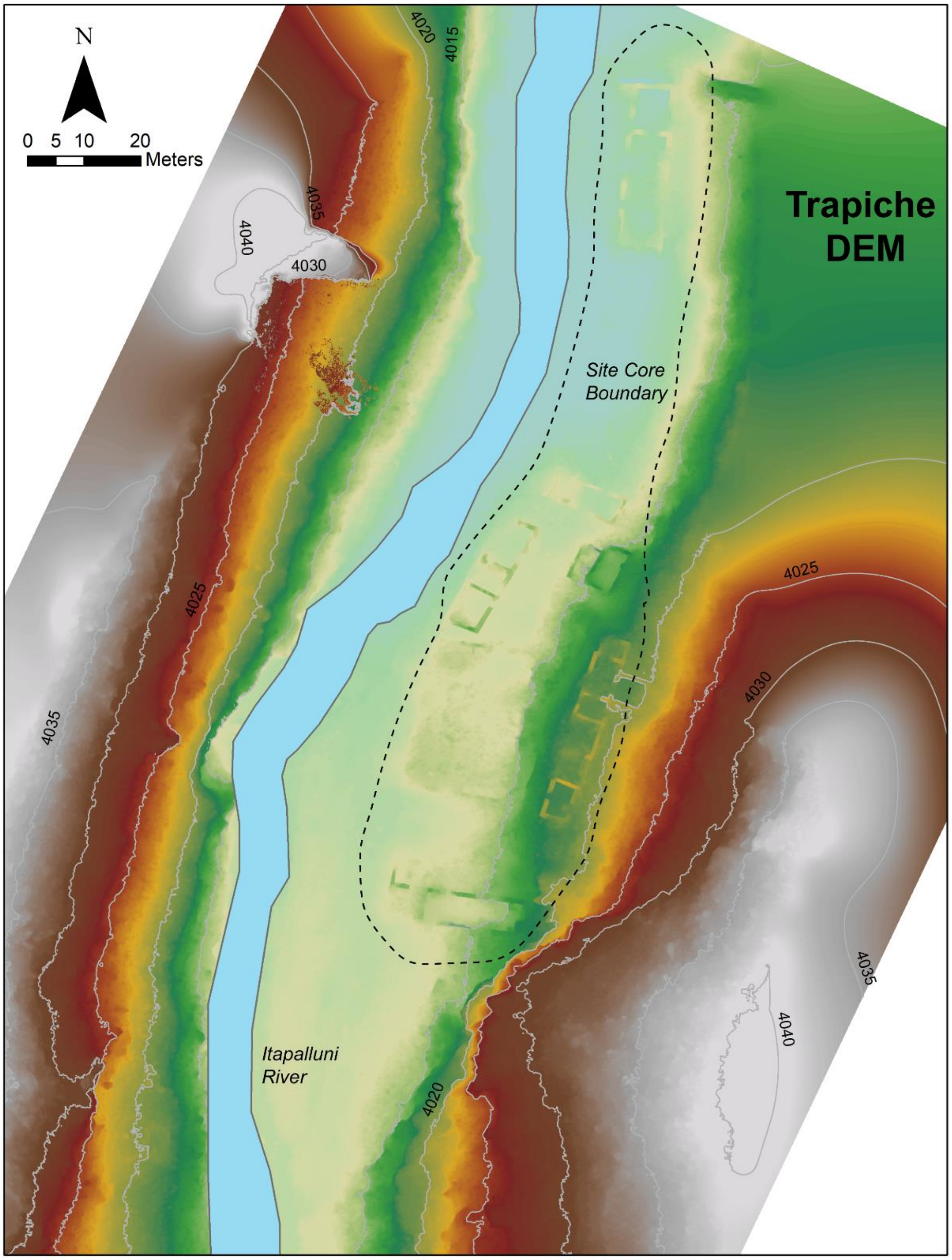

Figure 4.5: Digital elevation model (DEM) of the area surrounding Trapiche. Each contour line is 5 meters.

4.3 Surface Survey

Following the drone mapping of the silver refineries, we conducted a preliminary surface survey of the three best-preserved sites: Trapiche, Chorrillos, and Santo Cristo. These initial surface surveys consisted of walking the sites by foot and recording the size and dimensions of each structure, as well as the height of walls, using tape measures. The location of doorways, windows, and wall niches was also recorded with sketch maps and were photographed, as those details were not visible in the drone maps.

During the 2017 pilot season, surface artifacts were not collected at these sites. Instead, I counted and recorded surface artifacts in detail without collecting them. I placed recording units within each structure and divided open patio spaces into 10 m x 10 m units. All artifacts within each unit were counted, described, and photographed, but not collected.

4.4 Refinery Architectural Descriptions

Prior to excavation at Trapiche, we conducted a thorough survey of architecture at the site. We also conducted architectural surveys at additional refineries that had above-ground structures (San Juan, San Miguel, Santo Cristo, and Chorrillos). In the following subsections, I present the drone maps of these five refineries, as well as vectorized site maps created from the drone images and the surface surveys conducted in 2017. Additional information on refinery architecture, site layout, and occupation is also included.

4.4.1 **San Juan**

We first mapped the refining site of San Juan in July of 2017 (Figures 4.6 - 4.9). Two drone maps of San Juan show both a wide view (including the river), and a zoomed-in view, showing complex architecture. The site belonged to Mariano Mamani Puma in 2017. There were modern buildings and various families living at San Juan in 2017, and the families only gave us permission to conduct a quick mapping of the site with a GPS and drone. We were unable to conduct a systemic surface survey of the site. From the drone photos, at least two refineries with grinding stones were visible, as well as colonial canals, ovens, and a possible colonial chapel. San Juan sits on the San Miguel/Uncalliri River (Figures 4.10 and 4.11).

Drone maps of San Juan depict at least two separate grinding mills with their stones still in place (Figure 4.12). There is an extensive network of colonial, stone-lined canals that fed these mills, and water from the San Miguel River must have been diverted some distance upriver to feed the mills through these canals. The grinding mill appears to have been semi-converted into a chapel by 1818 AD (Figure 4.13).

Figure 4.6: Wide view of the San Juan refinery orthotiff image, overlaid on a land image of the area from Google Earth. The San Miguel River is visible to the north of the site.

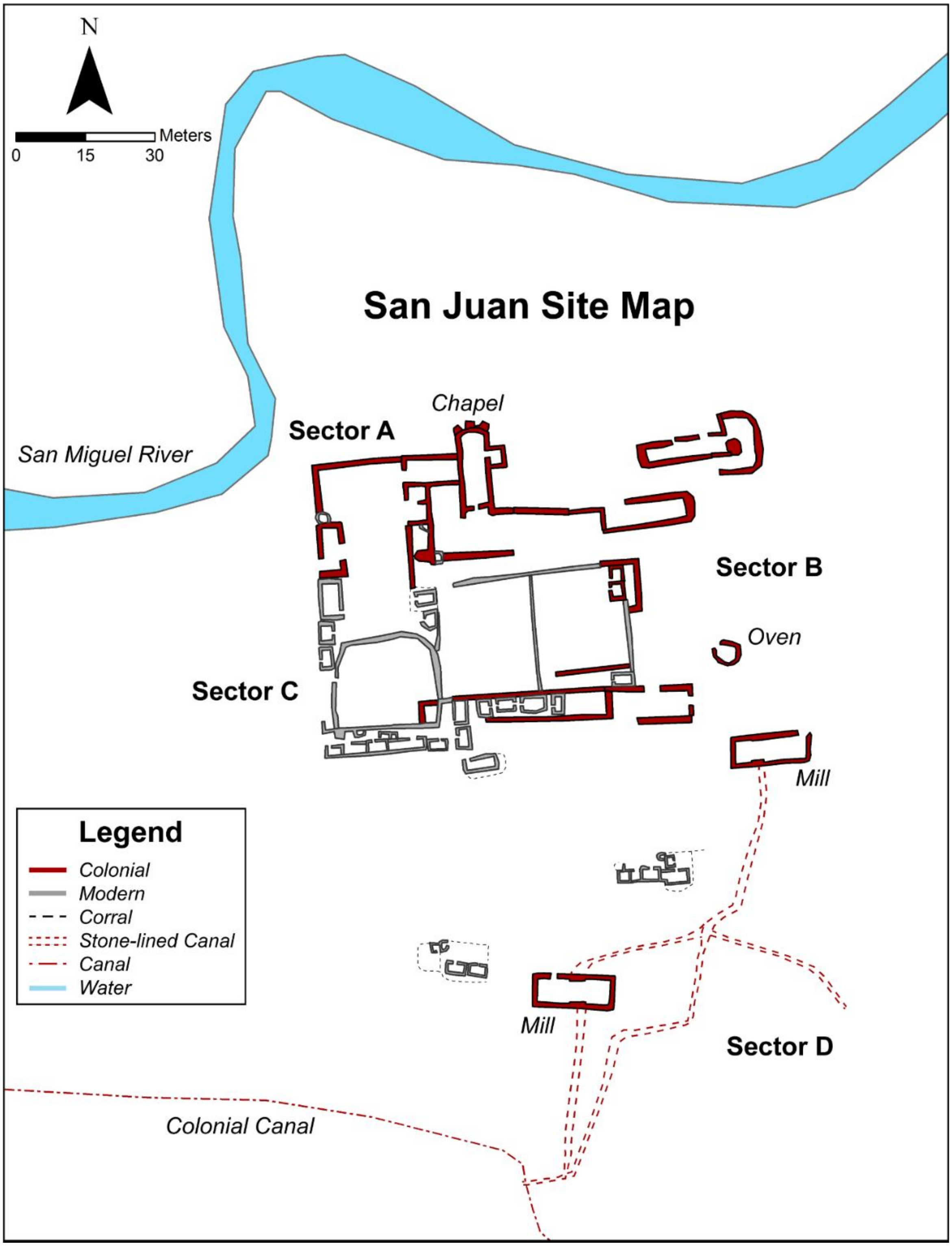

Figure 4.7: Vectorized version of the large, wide-view map of San Juan. The San Miguel River is visible to the north of the site.

Figure 4.8: Zoomed in, close-up view of the San Juan refinery.

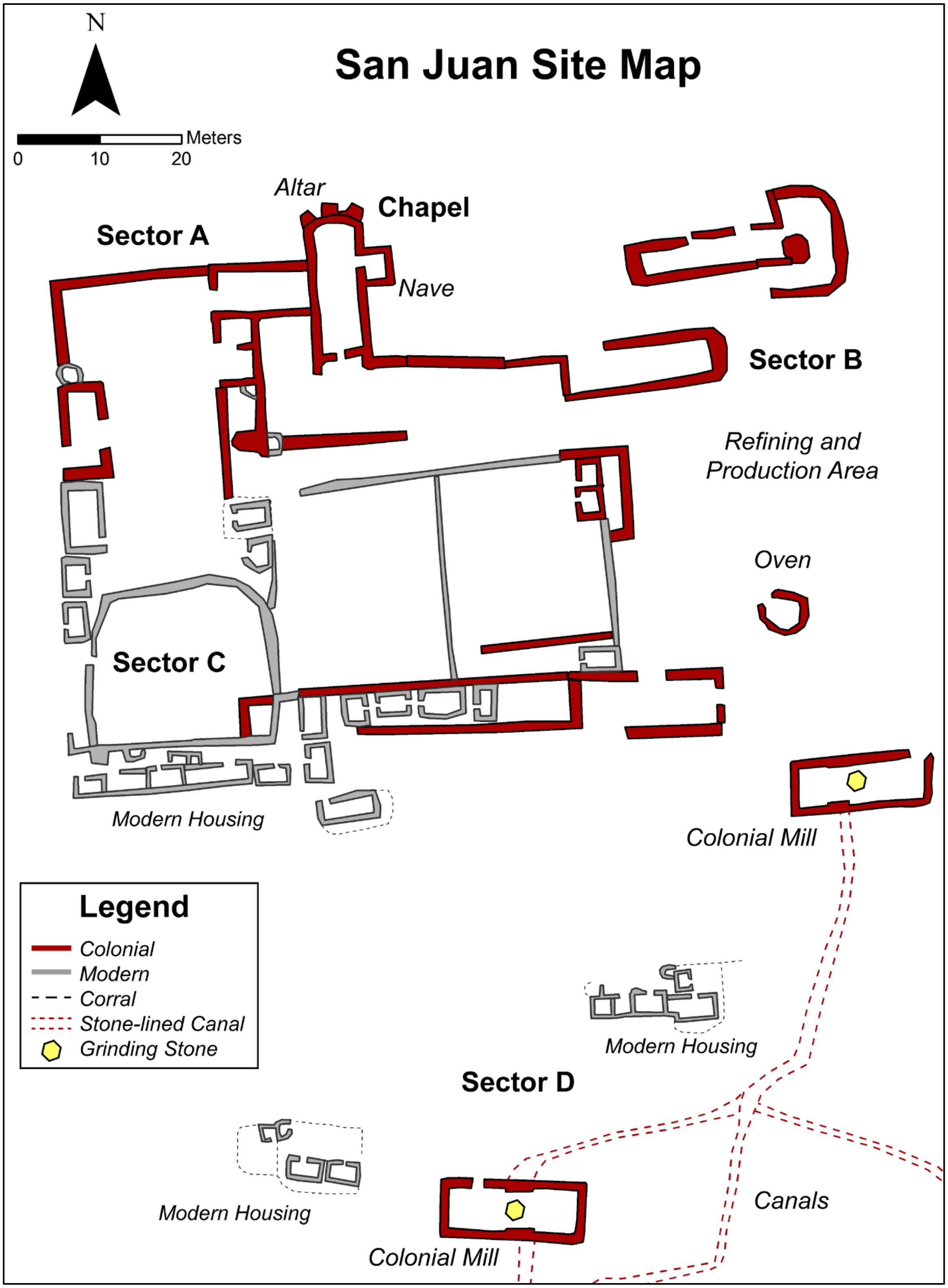

Figure 4.9: Zoomed in, close-up view of the San Juan refinery in a vectorized map.

Figure 4.10: View of San Juan looking west. The chapel is visible in the middle of the photograph.

Figure 4.11: Inside the possible chapel in Sector A of San Juan, looking west through the nave to the altar.

Figure 4.12: View inside the southern grinding mill in Sector D at San Juan, with the grinding stones still in place.

Figure 4.13: (Left) The side of one of the grinding mills in Sector D at San Juan, with the bottom canal still visible. It was turned into a chapel around the year 1818, evidenced by the date below the cross (right).

4.4.2 **San Miguel**

San Miguel was mapped in July of 2017 and the owner of the site, Sr. Eusebio, gave us permission to map and conduct a surface survey. The site was still in use by the Eusebio family, with many modern buildings and animal corrals for camelids, sheep, and cattle. It is located on the west bank of the San Miguel River, and modern surface mining efforts are visible to the west of the site. Southeast of the site are two large, modern circular arenas for catching and shearing sheep. In the northeast courtyard, a 20th chapel is still in use (Figure 4.14).

Colonial remnants of the San Miguel refinery include canals, building foundations, cisterns, and discolored soil and slag waste (Figures 4.15 – 4.17). In the animal corrals, there are remnants of colonial drainage canals and the main silver refinery. This refinery was apparently converted to a religious chapel around 1804 (Figure 4.18), repeating the same pattern observed at the San Juan refinery in 1818.

Figure 4.14: The San Miguel chapel, at the San Miguel refinery in Sector A. (Left) Inside of the chapel and (Right) outside of the chapel.

Figure 4.15: Drone orthotiff map of the San Miguel Refinery located on the San Miguel River.

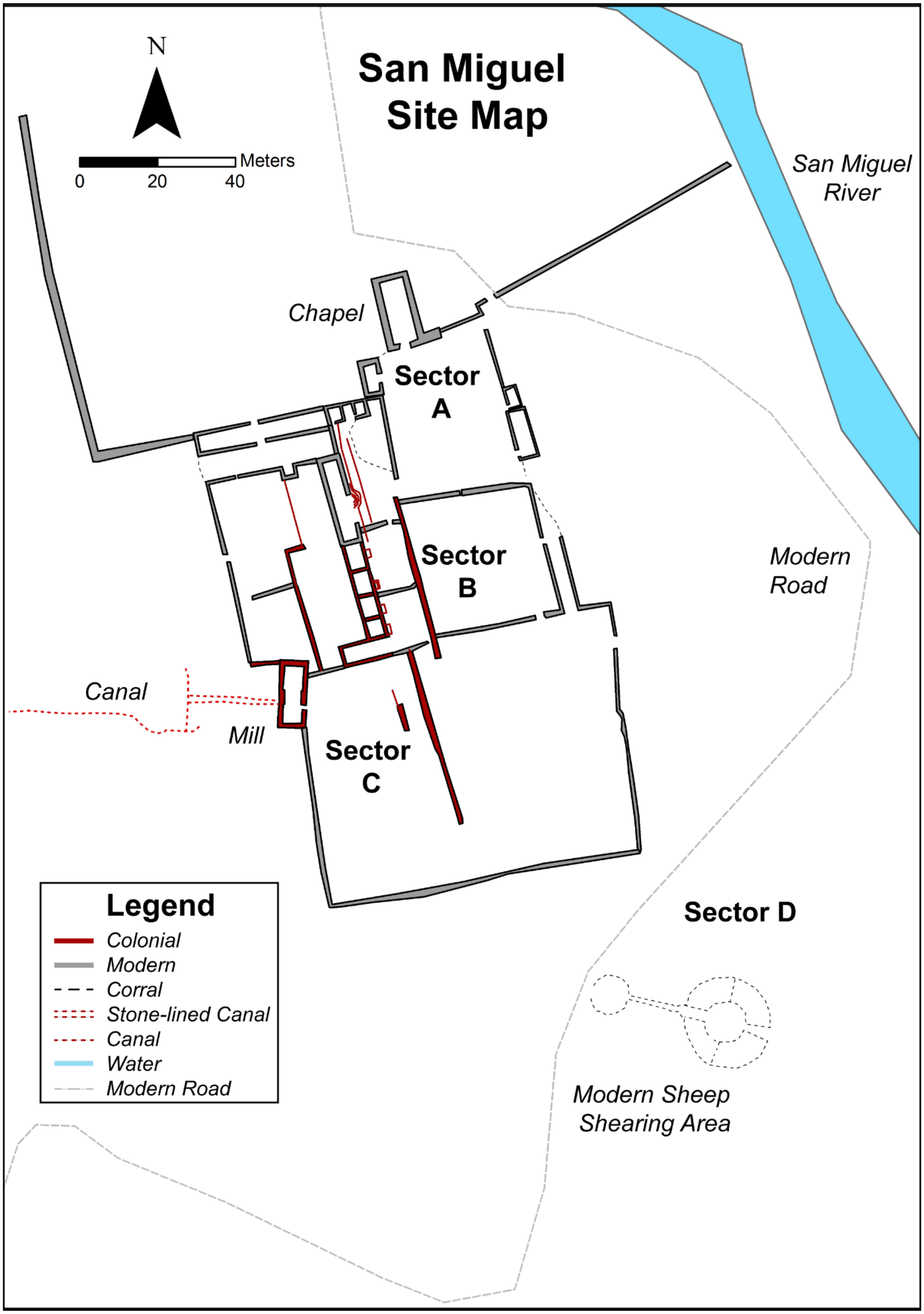

Figure 4.16: Vectorized version of the San Miguel site map, depicting colonial and modern architecture.

Figure 4.17: View of San Miguel looking west, uphill, in Sector C. The animal corrals are visible, with colonial arches, canals, and 19th century cross insets.

Figure 4.18: (Left) East side of the grinding mill in the northeast portion of Sector C. (Right) Close-up of the stone cross with the date of 1804, placed over the arched canal.

4.4.3 **Santo Cristo**

Santo Cristo was mapped in July 2017 and the owner of the site was Justo Medina, who gave us permission to map and survey the area (Figures 4.19 and 4.20). Medina had been using the site for storage and had taken building stones from the grinding mill/chapel and used them to replace stones in other buildings at the site. Santo Cristo sits on the San Miguel River.

Buildings in Sector A, the refining area, were large and likely had a canal that flowed through multiple buildings. They measured approximately 8 m x 4-5 m. Sector B included numerous small structures surrounding the central amalgamation patio. These structures were smaller and measured approximately 3 m x 2 m with 60 cm thick walls. Some of these structures included niches. Their doorways appear to have been built in the Andean, trapezoidal fashion, with smaller door widths on top (80 cm) than on the bottom (86 cm).

Sector C included the primary grinding mill and water reservoir (Figures 4.21 and 4.22). Like San Juan and San Miguel, the Santo Cristo mill appears to have been converted to a chapel around the turn of the 19th century. The entrance to the chapel/grinding mill measured 7 m x 4 m, with at least 4 niches. Sector D contained possible administrative structures on a hill above the site, measuring between 8 m x 8 m and 8 m x 16 m. A modern road cut through a colonial midden between Sector's A and D, and charcoal, animal bones, and tin-glazed colonial majolica pottery were visible.

Southwest of Santo Cristo, approximately 100 m from the site boundary, was a collection of mercury ovens (not pictured on map) (Figures 4.23 and 4.24). These included burnt earth, adobe bricks, and rocks, and inside were numerous fragments of mercury pot rims that correlate to mercury pot fragments found at Trapiche Itapalluni (see Chapters 7, 8, and 9).

Figure 4.19: Orthotiff drone map image of Santo Cristo, overlaid on a Google Earth photo.

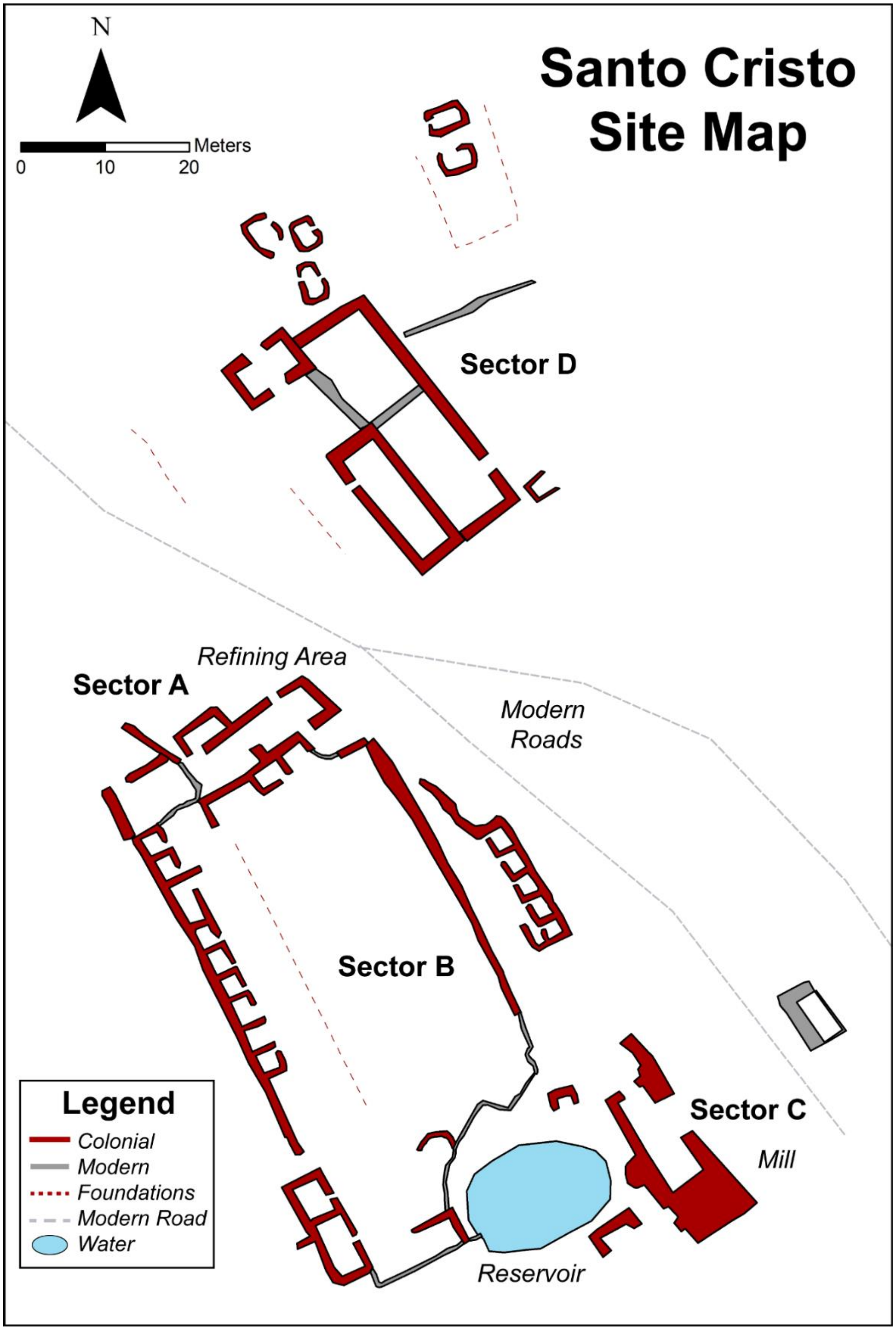

Figure 4.20: Vectorized sitemap of Santo Cristo.

Figure 4.21: View of Santo Cristo looking west, above the mill/chapel in Sector C. The reservoir is visible north of the mill. The open work patio is in the center-right.

Figure 4.22: View of the opening of the grinding mill/chapel in Sector C, looking southwest.

Figure 4.23: Mercury ovens west of Santo Cristo. This photograph was taken looking east, toward the site, which is visible in the background on the side of the slope.

Figure 4.24: Mercury pot rims found on the surface west of Santo Cristo, in what appears to have been colonial mercury ovens.

4.4.4 **Chorrillos Itapalluni**

The site of Chorrillos Itapalluni ("Chorrillos") sits on the northern Itapalluni River and was an ore processing site for the San Luis de Alba mining district, sitting within 2 km of San Luis de Alba (see Chapter 3) (CTAR 1999; Schultze 2008).

Chorrillos was first described by Lechtman (1976) during an extensive survey of Andean metallurgical sites in the 1970s. In 1999, the Puno regional government (*Concejo Transitorio de Administración Regional*, or CTAR) identified Chorrillos during a mapping project intended to evaluate the San Luis de Alba mining district for its potential to the local tourist industry. In their report, they describe oral traditions of Chorrillos as a prison or fort and give it alternative names such as the "Carcel de Chorrillos" and "San Juan de Chorrillos" (CTAR 1999). Chorrillos is also often confused for the mining camp of San Luis de Alba.

During the 20th century, Chorrillos was part of the Hacienda Itapalluni, and portions of the site were converted into a corral and slaughterhouse for animals (CTAR 1999:14). Chorrillos erroneously became known as San Luis de Alba when a group of historians published an article describing Chorrillos as the original *asiento de minas* of San Luis de Alba and mistakenly named it "Fuerte de San Luis de Alba" (CTAR 1999).

Chorrillos was first mapped by the CTAR survey, and then later summarized in a report on colonial Puno mining by Mario Nuñez (2001), where the original site map was published (Figure 4.25). I visited Chorrillos in 2016, 2017, and 2018, and first mapped Chorrillos in July of 2017, confirming its use as a colonial silver refinery (Figures 4.26 – 4.28). My site maps retain the original Sector designations that Nuñez originally gave the site in 1999. The site sits along a steep hill on the Itapalluni River and has four separate sectors.

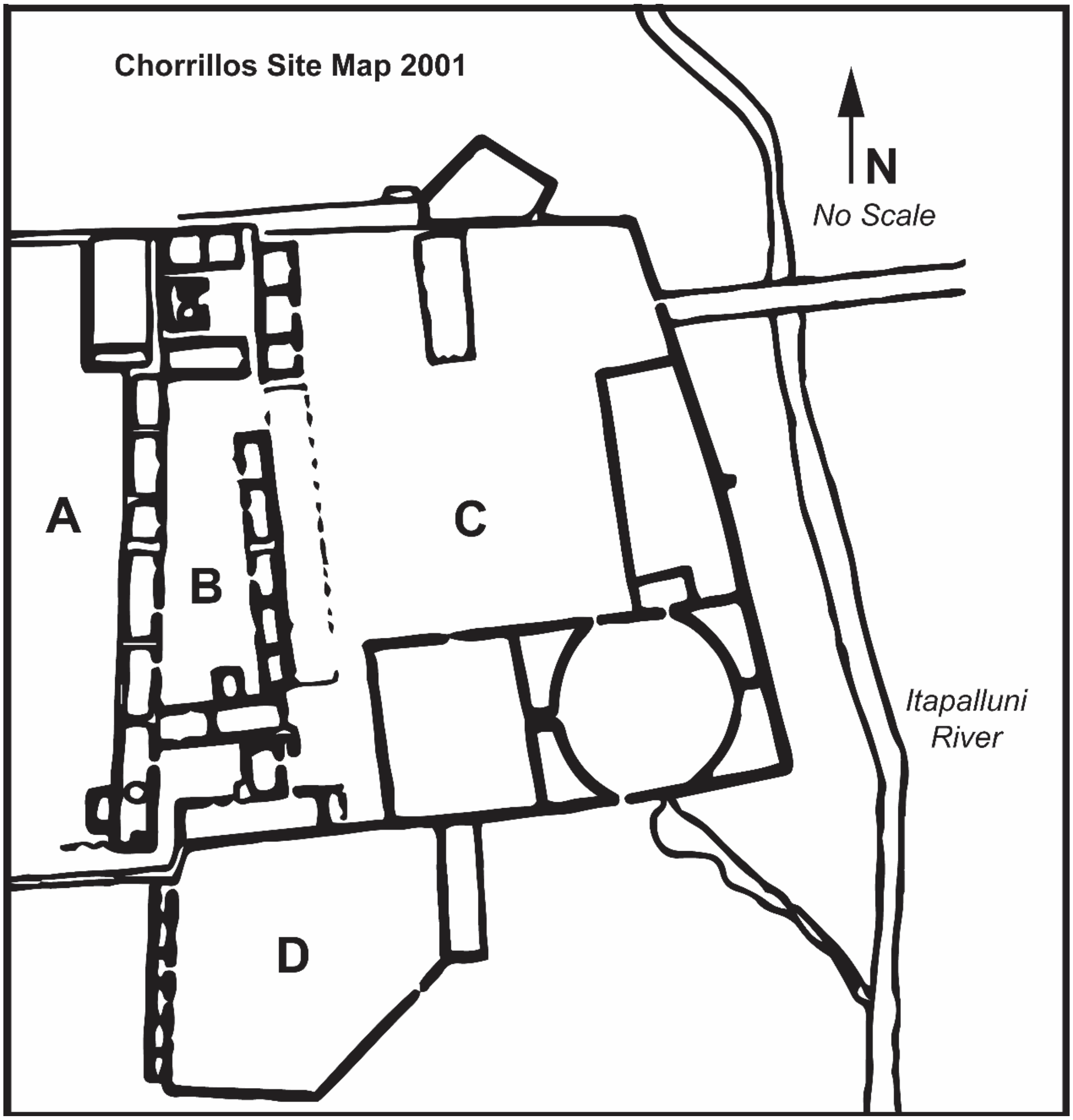

Figure 4.25: Redrawn site map of the Chorrillos silver refinery from Nuñez 2001. Sector A structures are not shown in this map, and there is no scale. Redrawn by Kennedy in 2020.

Figure 4.26: Ortho-tiff drone map of Chorrillos Itapalluni produced in 2017.

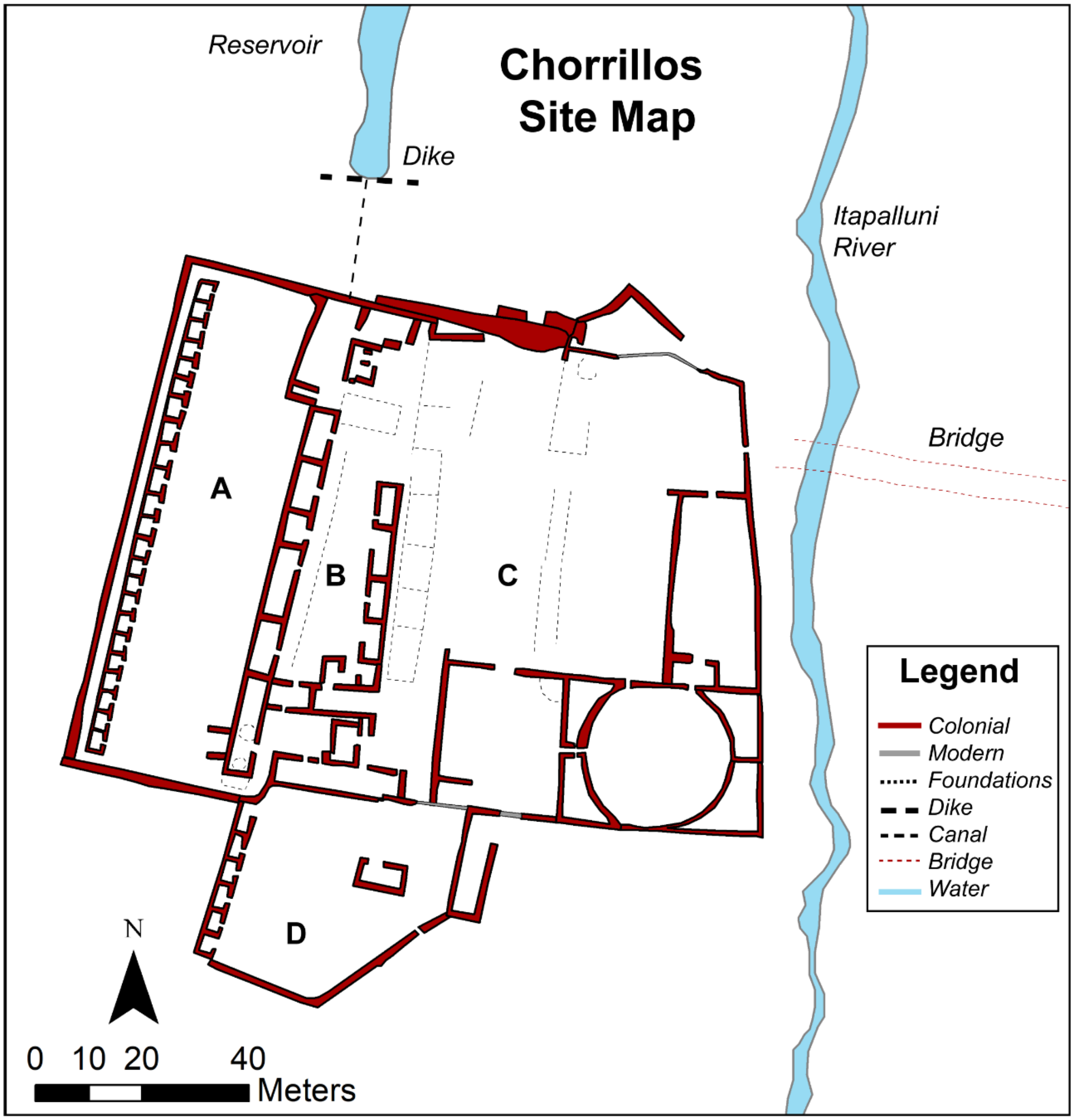

Figure 4.27: The 2017 vector map of Chorrillos, depicting colonial and modern architecture and building foundations onsite.

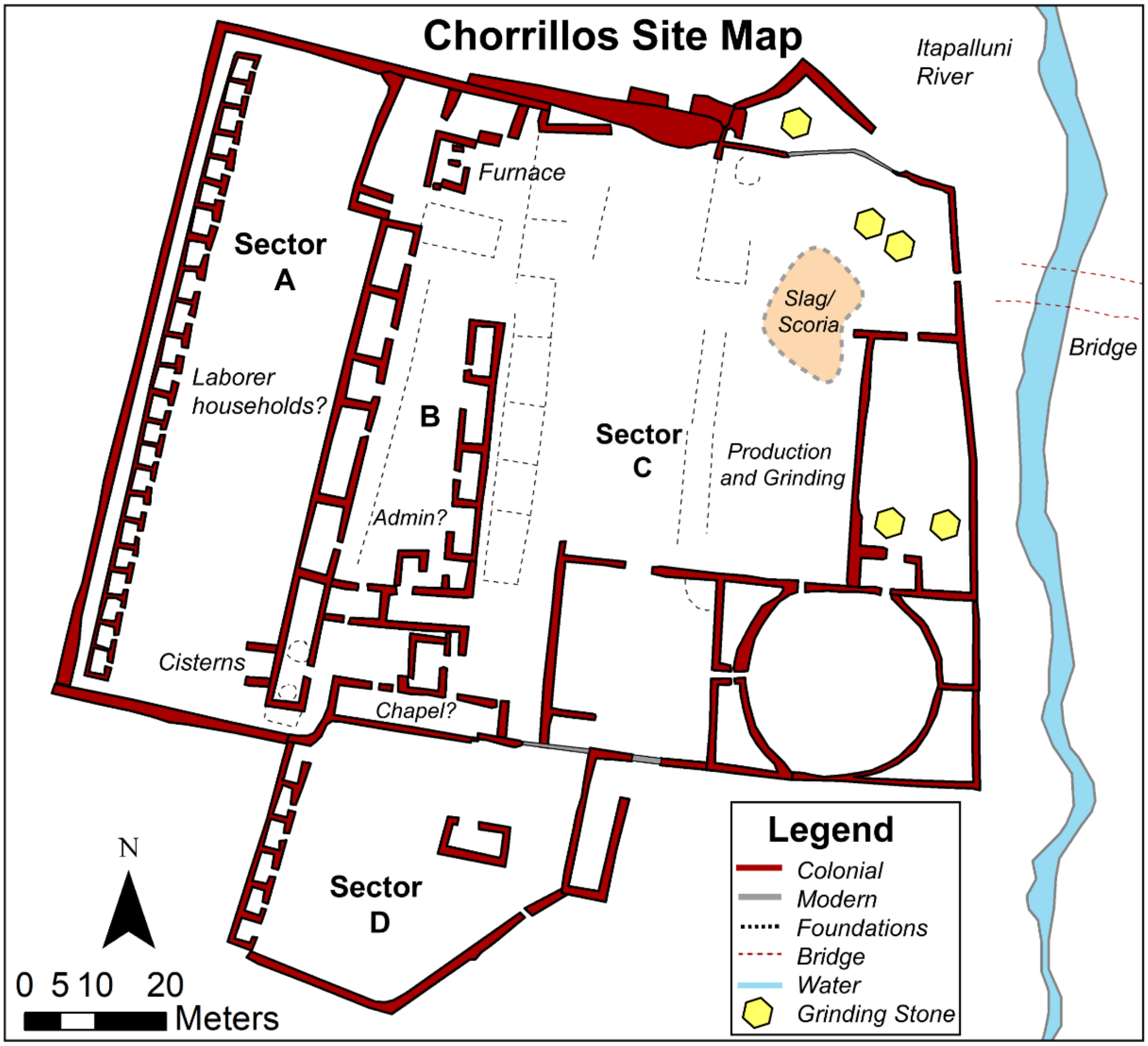

Figure 4.28: Site map of Chorrillos with activity areas labeled.

Sector A of Chorrillos includes 23 small structures located on the western edge of the site. These may have been housing for indigenous laborers (CTAR 1999:14-15; Nuñez 2001:46; Schultze 2008) or used for storage (Figures 4.291 and 4.30). There is a corridor directly behind the small structures to the west (2 m in width), as well as a possible canal on the eastern edge of the patio, that may have flowed north to south (CTAR 1999:14).

Sector B was a mixed-use area, used as both an administrative area and refining zone (Figure 4.31). There is a possible chapel located in the southern zone of this area. This area includes large structures surrounding a central patio for administration and storage, with many glazed and unglazed colonial ceramics (Figure 4.32). There are also sedimentation and amalgamation cisterns (Figure 4.33), as well as ovens and furnaces (CTAR 1999:15; Nuñez 2001:45-47).

Sector C was likely the primary zone of production, as large hand-powered grinding stones (*quimbaletes*) were found with large amounts of slag and scoria (Figure 4.34). Sector D may have housed women working to support and cook for laborers (CTAR 1999:16; Schultze 2008). It contains smaller structures that may have been residences, as well as a large patio and platform area. This may have also been a location to house the muleteers who transported ore between sites, as they were often kept separate from laborers to avoid the smuggling of silver.

Chorrillos is much larger than other Puno refineries and does not show evidence of a water-powered grinding mill. Chorrillos likely functioned as an *ingenio* which used expensive ore-crushing mallets or *cabezas*. Chorrillos appears to have been occupied for a longer period than the other refiners as well, and likely served as an important silver refining complex for the Puno Bay throughout the 16th – 19th centuries. Bottle glass was found on the surface of Chorrillos and indicates occupation well into the Republican Period (19th and 20th centuries). Glass was not found at Santo Cristo or Trapiche.

Figure 4.29: View of Chorrillos looking west from the Itapalluni River, with small houses visible near the back wall.

Figure 4.30: Small worker cell or dormitory, located in Sector A in the western portion of Chorrillos. Note the small doorway and the trapezoidal form.

Figure 4.31: Arched doorway of a large administrative structure in Sector B of Chorrillos. Looking west through the doorway to the work patio far below.

Figure 4.32: Colonial ceramics found on the surface of Chorrillos.

Figure 4.33: A cistern located in the southeast portion of Sector A of Chorrillos.

Figure 4.34: A quimbalete grinding stone on the ground at Chorrillos.

To date, no archaeological excavation has been done at Chorrillos to test the function of the western rooms in Sector A (Figure 4.35). Surface scatter revealed no evidence of hearths, and only a handful of domestic and colonial period ceramics were found throughout the western sector. The space immediately adjacent to these structures was the western patio, which likewise revealed little in surface remains that could have indicated domestic functions related to food preparation or consumption. However, these patterns may not be very revealing of prior site activities, as only a limited number of surface artifacts were found in general. Poor surface preservation, as well as frequent surface looting, likely contributed to this lack of material.

Figure 4.35: The western portion of Sector A at Chorrillos, with the 4 m high wall visible behind the small "worker barracks" structures.

4.4.5 **Trapiche Itapalluni**

The site of Trapiche Itapalluni ("Trapiche"), located 12 km southwest of Puno, was first located and recorded during the summer of 2017. The site sits in a deep, narrow valley next to the Itapalluni River, with tall cliffs jutting up on either side of the river. It encompasses 6,000 m^2 (0.6 hectares) and includes more than 30 stone structures and at least five separate sectors, as well as multiple patios and one midden (Figures 4.36 – 4.38). Surface artifact surveys were conducted at the site in 2017 and 2018. Surface ceramics included tin-glazed majolica and Spanish olive jars, representative of colonial occupation, as well as utilitarian and domestic wares (Figure 4.39). We also found burnt adobes and bricks in areas thought to be metallurgical ovens (Figure 4.40). Subsequent excavation of the site occurred in 2018, concentrating in Sectors A, B, and C. We did not receive permission to excavate in Sectors D and E. More detail on the surveys and excavations at Trapiche can be found in Chapters 5-9 of this dissertation.

Figure 4.36: Drone orthotiff map of the architectural core of Trapiche, on top of Google Earth imagery.

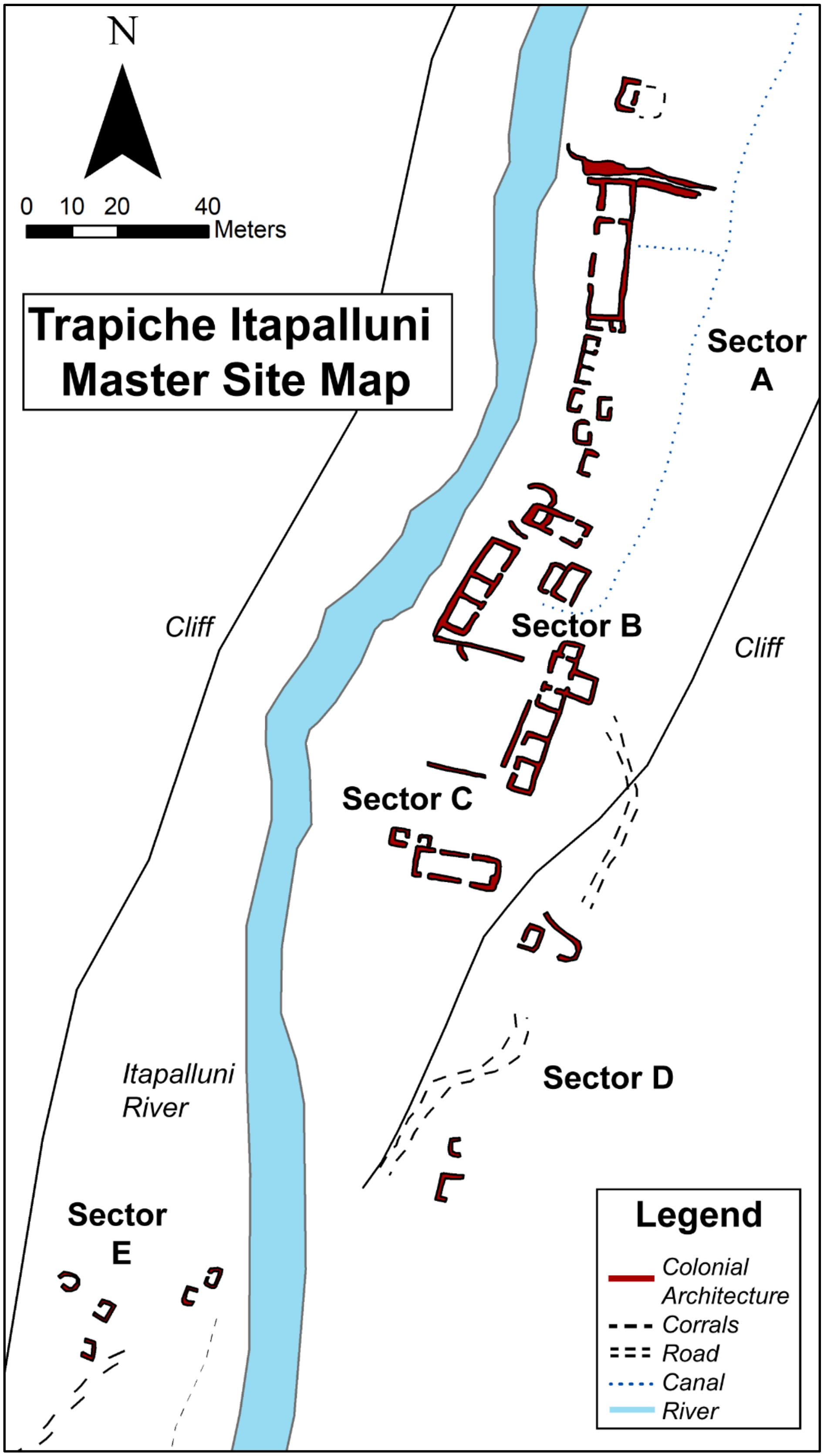

Figure 4.37: Master site map of Trapiche Itapalluni, with all 5 sectors (A, B, C, D, and E).

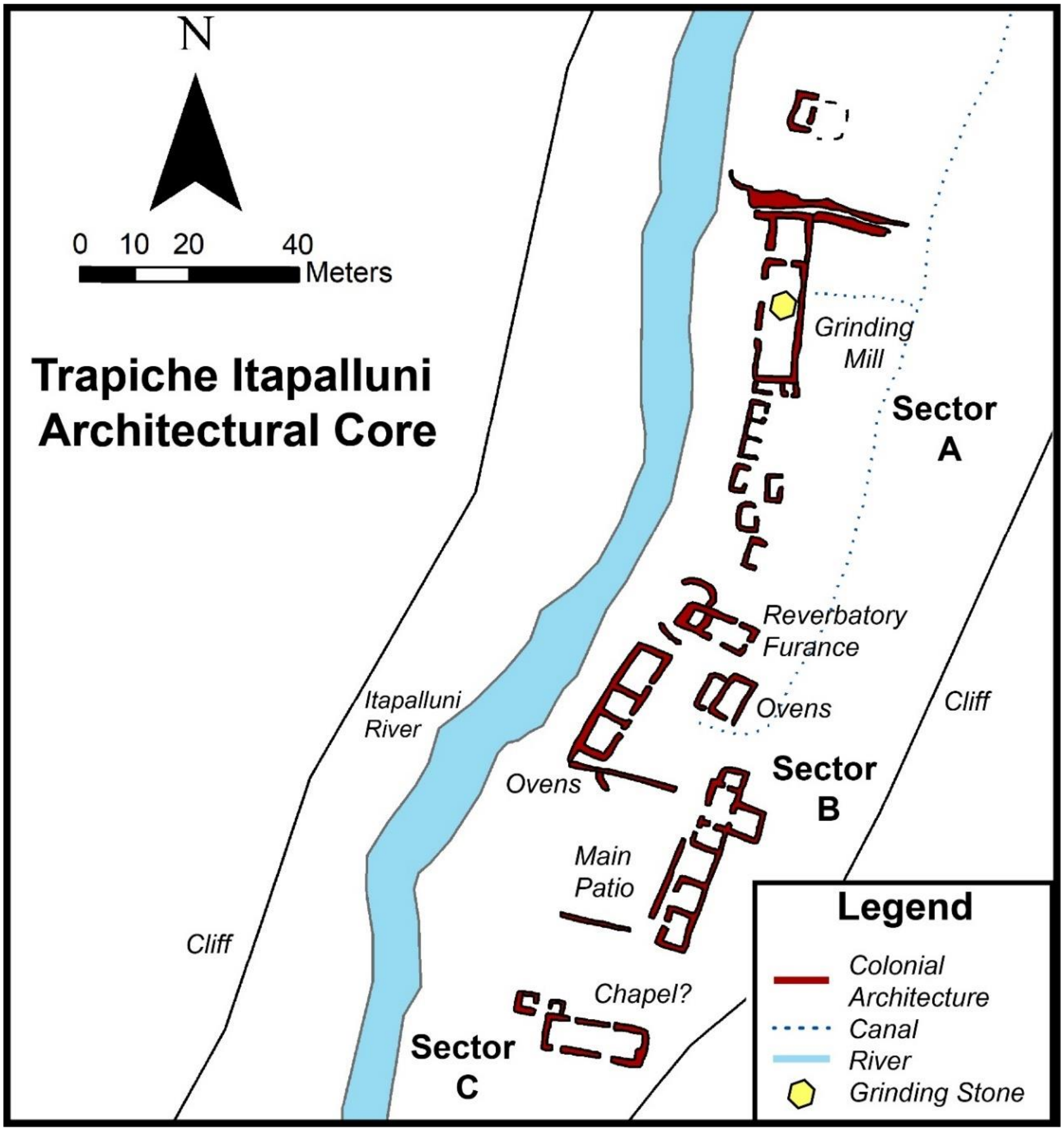

Figure 4.38: Detailed, zoomed in map of Trapiche's architectural core, showing the location of the grinding mill, furnace, and ovens.

Figure 4.39: Colonial ceramics found on the surface of Trapiche Itapalluni. (Left) a possible ceramic mold to produce silver ingots, and (Right) fragments of local style ceramics.

Figure 4.40: Burnt earth and adobe from the reverberatory furnace at Trapiche.

Sector A was the northern sector of Trapiche and is primarily associated with the hydraulic mill and mineral grinding activities (Figure 4.41). There were also stone-lined canals that fed the mill from the upstream current of the Itapalluni River. In addition to the mill, Sector A included small structures believed to be laborer houses and storage structures. Seven of these structures measure approximately 3 m x 2.5 m. There was also a structure located north of the mill and may have been used as an outpost or a location for muleteers or other individuals who would have passed in and out of Trapiche. We did not receive permission to excavate this structure in 2018.

The principal water canal that fed the mill is located roughly 20 m to the east of the mill (Figure 4.42). It is located on an uphill slope, using gravity to add power to the downward flow of water. The canal begins roughly 100 m to the north of Trapiche, taking water from the Itapalluni River. The Trapiche mill as it appears today, in its final phase of occupation, resembles a gristmill (*trapiche*), where two large ground stones are rubbed together, powered by workers moving the stone. Water is added as a lubricant for the process. Gristmills did not need a large reservoir of water to power their grinding stones.

We did not find evidence for the presence of large stamp-head mallets (*ingenios*) at Trapiche, although we did record an aqueduct on the northern wall of the site (Figure 4.43 and Figure 4.44). Water from the canal would have been diverted to this aqueduct before it reached the grist mill. The aqueduct appears to have carried water from the canal downhill toward the aqueduct, which was large enough to fit a wooden water wheel (Figure 4.45). We also recorded a worked stone slab directly north of the mill, across the deep canal, which could have been part of the water wheel structure or a discarded *quimbalete*.

Figure 4.41: View of the grinding stones within the grinding mill at Trapiche.

Figure 4.42: Aerial view of Trapiche looking north. The colonial canal is the visible yellow line running parallel to the Itapalluni River.

Figure 4.43: A view of the north wall of Trapiche, looking west toward the Itapalluni River. The wall appears to have been an aqueduct, with a central depression carrying water from the canal.

Figure 4.44: The canal running directly north of the mill, fed by the aqueduct. (Left) A view looking east from the river, and (Right) a view of the canal looking south, into the site. The arrow indicates a carved rock that likely held a wooden beam, perhaps for a water wheel.

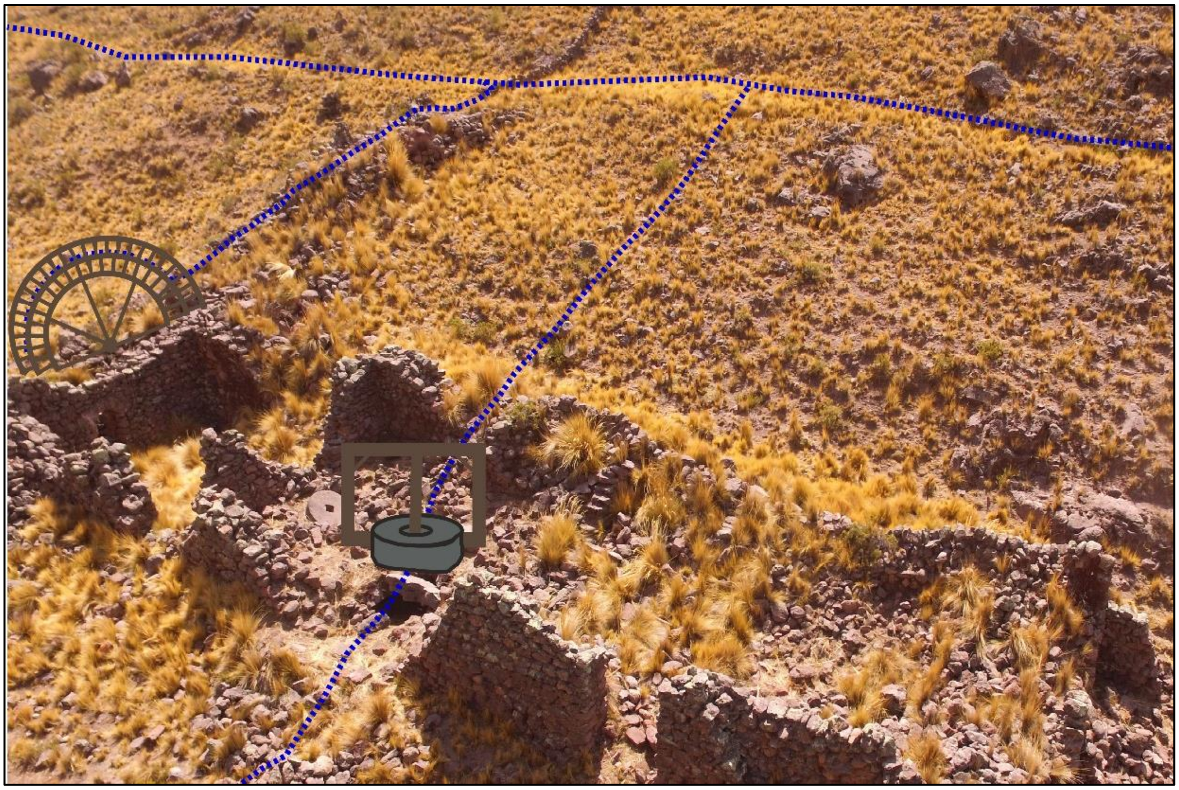

Figure 4.45: Aerial view of Trapiche's mill, looking north east. The canals and aqueduct are highlighted with a dashed-blue line, and I have drawn in what the water wheel and grist mill may have looked like.

Sector B was likely both a refining area and administrative zone, with a large work patio, a reverberatory furnace, mercury ovens, tanks, canals, and administrative structures. The structures in Sector B measure approximately 7.5 m x 4 m, and the reverberatory furnace measures 12 m x 4 m. Sector B is also the location of the possible overseer/owner's house.

The reverberatory furnace in Sector B was identified based on early colonial writings of silver refineries. In *Arte de los Metales*, written by Alvaro Alonso Barba in 1640, reverberatory furnaces (*hornos de reverberación)* are differentiated from smelting furnaces or ovens (*hornos de fundición*) (74v-75r). According to Barba, reverberatory furnaces were for roasting and preparing ores for amalgamation (1640:74v-75r). They were large and rectangular, and had arched rooves, fire boxes, and grated bars for separation of ashes during roasting (Figure 4.46). They were open at the top with chimneys to carry away the “evil substances” (i.e., smoke) (1640:75v-76r).

Ores were roasted in the reverberatory furance to facilitate grinding and to prepare them for amalgamation by removing “interfering evils” (Barba 1640:75v-76r). Barba states that firewood is the preferred fuel for these furances, but *yareta* (a local highland shrub) and *taquia* (llama or cow dung) could also be used. However, when smelting ores at later stages of refining, wood or charcoal was needed to create the required high temperatures (Barba 1640:77r-80r).

Figure 4.46: Barba's depiction of different parts of the reverberatory furnace. Barba 1640:76r.

Figure 4.46 lists the parts of a reverberatory furnace as: A) the foundation of the furnace; B) the floor built on arches; C) fire doors; D) grate bars; F) a round furnace; G) a rectangular furnace; and H) chimney.

At Trapiche, the reverberatory furnace is located in Sector B, Structure 11 (Figure 4.47 and Figure 4.48). Structure 11 is the principal furnace itself, with large supporting walls circling the structure. While it would have been originally framed with arches, the center has since collapsed. Within the furnace, we found remains of burnt earth, burnt clay, and vitrified materials, all indicating the location of a furnace that burned with high heat. Structure 12 is the rectangular structure attached to the east side of the reverberatory furnace and it was likely used to store fuel, such as *yareta* and *taquia*.

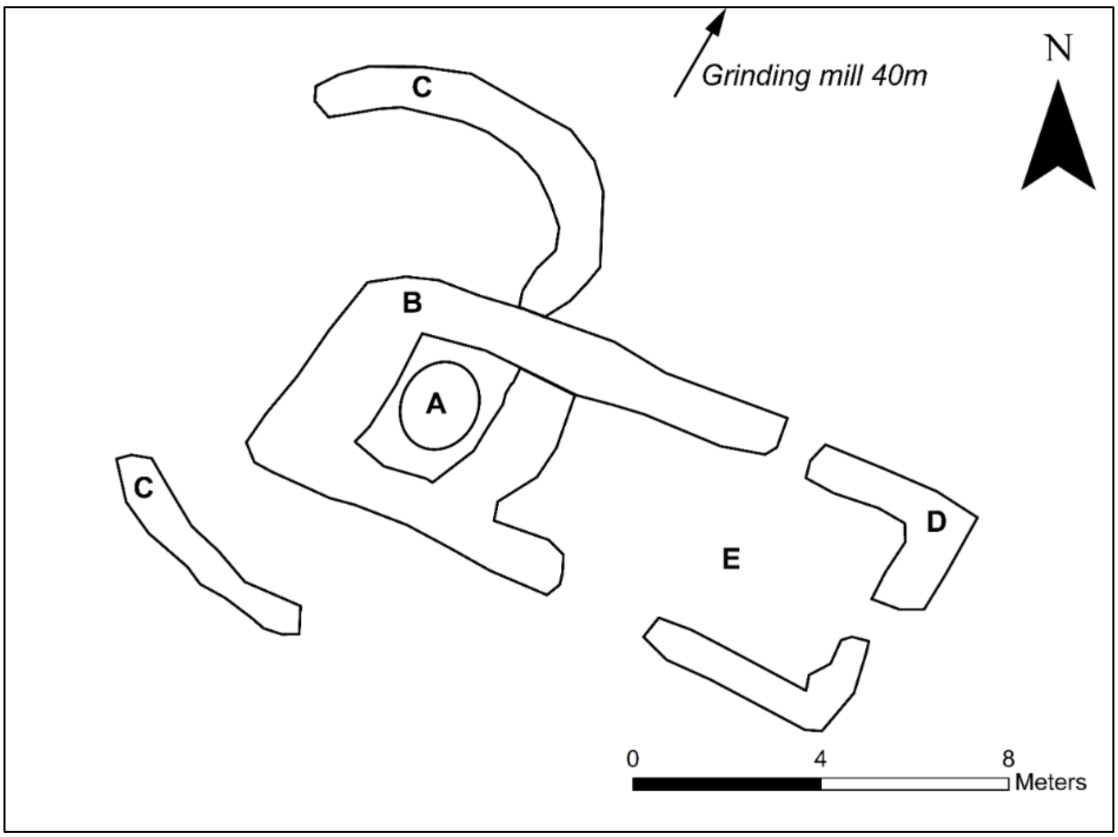

Figure 4.47: Architectural drawing of the reverberatory furnace at Trapiche, labeled following Barba's letters and terminology from Figure 4.46.

Figure 4.48: Aerial view of the reverberatory furnace looking east. In the foreground, the main structure of the reverberatory furnace has collapsed.

Sector C included the large chapel, adjacent chapel-related structures, a small patio, the communal midden, and the principal entrance to the site. The large chapel (~ 8 m x 18 m) served as an important location near the entrance of the site, which would have been well-situated to control the movement in and out of Trapiche. It is also included multiple wall niches and plaster walls and floors. The chapel is one of only two structures at Trapiche to be oriented east-west, which is common for chapels built during this period (the other structure is the reverberatory furnace). Additionally, the chapel was likely used during early occupation of the site and was then expanded for multi-purpose use at the end of the site's occupation in the 18th century (see Chapter 7 for more information on site occupation dates and excavation stratigraphy).

Sector's D and E were located south of the architectural core of Trapiche, in the southern periphery of the site. Sector D includes portions of a colonial road, patio, and three building foundations atop a hillside cliff overlooking Trapiche and the valley beyond. This area may have served as an outpost or location of surveillance for traffic in and out of Trapiche. Surface artifact scatter around Sector D included high proportions of Spanish tin-glazed majolica as well as Spanish olive jars (*botijas*) used for storage and transport of materials.

Sector E was located further southwest of Sector D, on the west side of the Itapalluni River. This sector included remains of at least five building foundations, as well as a platform or canal, and sectors of a colonial road. Future excavations in Sectors D and E would be beneficial for understanding how trade in and out of the site occurred. Furthermore, these excavations would also potentially locate additional housing and cooking areas associated with the site, including housing for muleteers and other tradespeople, as well as for guards and sentinels for the site.

4.5 Puno Refineries in the Archives

The majority of secondary sources (e.g., Schultze 2008) that detail colonial silver refining in the Puno Bay highlight the period *after* the discovery of the Laicacota silver mine in 1657. However, through my archival research, I have found evidence that silver mining and refining occurred much earlier in the region, decades prior to the discovery of Laicacota. Primary historical sources point to the initiation of a silver refining industry in Puno around the early 1640s. In this section, I summarize information from various archival sources to describe a timeline of silver refining in the Puno Bay. I begin with a presentation of five refineries that were built prior to the discovery of the Laicacota silver mine in 1657 (Figure 4.49).

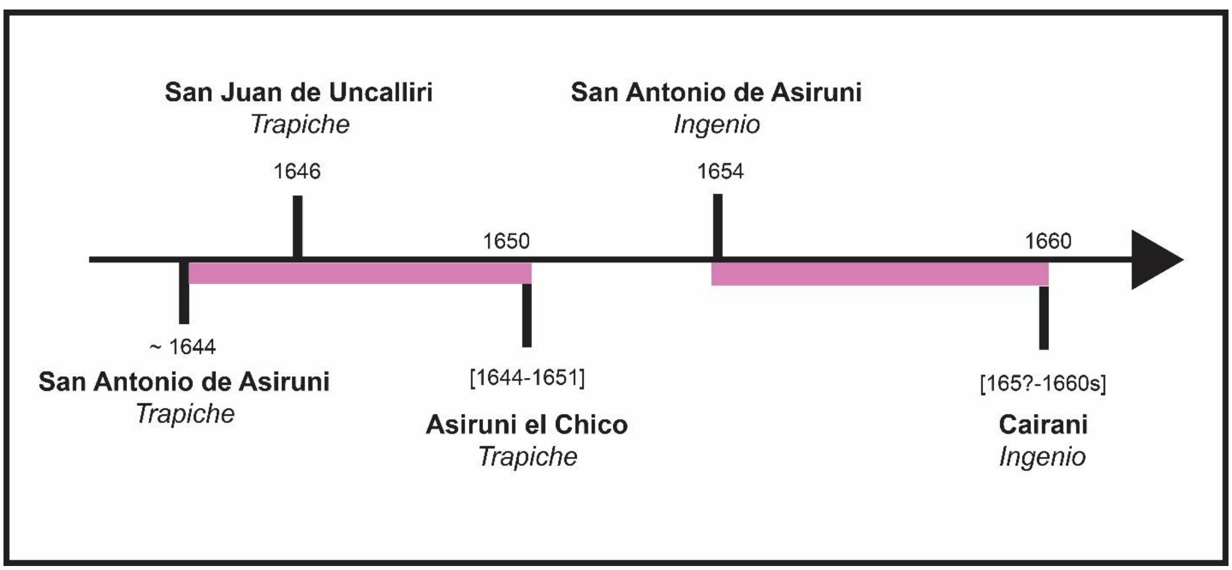

Figure 4.49: Timeline depicting the construction of five early silver refineries in the Puno Bay. The purple lines represent the broad time periods when Asiruni el Chico and Cairani were built (we do not know the exact date).

4.5.1 **San Antonio de Asiruni Refinery**

The earliest known refinery in the Puno Bay was a *trapiche* named San Antonio de Asiruni, located just a few kilometers south of Puno (Figure 4.50). It was built sometime before 1644 and the first recorded owner was Captain Antonio Pimentel, who owned it as early as 1644 (ARP Caja 05, E-126-1805-04). Pimentel was a local *minero* (mine owner) and used the refinery to process his silver from the Puno-area San José mines. After seven years of ownership, Pimentel sold the refinery to Gaspar de Salcedo in 1651 (ARP ibid.).

Gaspar officially christened the refinery “San Antonio de Asiruni,” although it has become known simply as “Salcedo” in modern times. Gaspar apparently paid Pimentel 1,700 pesos in cash for its purchase (ARP ibid.; Domínguez 2006:312, 341). Three years after purchasing the *trapiche*, in May of 1654, Gaspar received permission to build a second refinery in the same area. The second refinery was a larger *ingenio*, necessary for processing the massive influx of ore from his silver mines in San Antonio de Esquilache (see Chapter 3, also ARP ibid.; Domínguez 2006:341).

Gaspar de Salcedo’s Asiruni refineries were the primary locations he used to refine his ore from San Antonio de Esquilache, and later, Laicacota. The refineries were located just 2 km east of Cerro Cancharani and very near the road to Chucuito and Potosí. The refineries do not survive today, and I was unable to conduct architectural survey there in 2017.

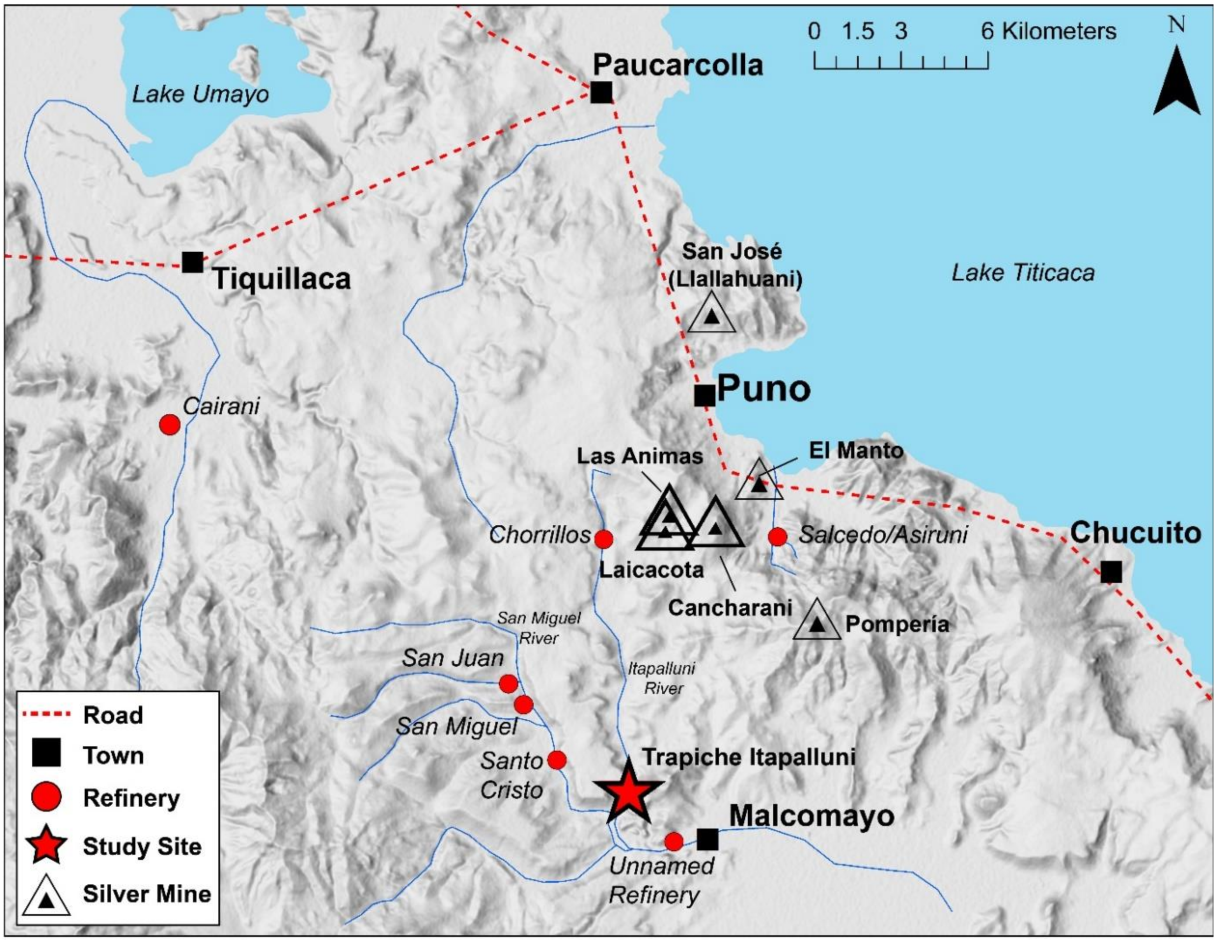

Figure 4.50: Location of silver refineries and mines in the Puno Bay. The site of Trapiche Itapalluni is marked with a large star.

4.5.2 San Juan de Uncalliri Refinery

Pimentel owned a second *trapiche* in the Puno Bay called San Juan, built in 1646 on the San Juan *estancia*. He received permission to build the refinery near a river on the property, which was owned at the time by Francisca Martinez de Rivera. The refinery was said to be located on the Uncalliri[14] River, roughly 10 km southwest of Puno (ARP, Fondo Notarial, Caja 006-E-165-1806).

[14] The spelling of this river is not standardized. It appears in various forms in the archives, such as “Uncalliri” or “Encallire.” I have chosen to use the Uncalliri spelling in my own writing.

The refinery was located at the convergence of two rivers, one of which was Uncalliri. In his request to build, Pimentel states:

> *Capitán Antonio Pimentel dueño de minas en este asiento de San Joseph de Puno, como más allá lugar de derecho, y al mío convenga diga que en estancia de San Juan de (Encallire) [Uncalliri] de Francisca Martínez de Rivera jurisdicción de este pueblo hay dos arroyos de agua que acercan y se juntan y recuperan más abajo de la dicha estancia distancia de media legua de las casas de ella media legua poco más a menos la cual dicha ( ) de aguas y paraje donde mejor me conviene, pido sitio servido para fabricar y fundar un trapiche para moler metales de plata y aumentar los quintos reales (ARP ibid.: folio 1-2).*

> Captain Antonio Pimentel, mine owner in the seat of San Joseph de Puno, moreover, as is the law, and of my agreement, states that within the San Juan de (Encallire) [Uncalliri] estate, owned by Francisca Martínez de Rivera, in the jurisdiction of this town, there are two streams of water that meet and join below the said estate, at a distance of half a league from her houses, a little more than half a league, more or less, of the said (?) of water, and at the location which suits me best, I ask permission to build and establish a *trapiche*, to grind silver ore and to contribute to the royal fifths (ARP ibid.: folio 1-2. English translation and italics my own).

This location, so suitable to build a powerful refinery, is likely the same spot where the present-day San Juan refinery is located, 11 km southwest of Puno. The refinery sits at the intersection of two streams, the San Miguel River, and a small, unnamed tributary. It is very like that Uncalliri was the original name of the San Miguel River. The word "Uncalliri" comes from the Aymara language meaning "with ducks," (*uncalla* = duck, and *iri* = with) (Javier Chalcha, personal communication 2019). This was likely the local name for the San Miguel River, and this refinery is same site as "San Juan," which I mapped in 2017.

The San Juan de Uncalliri *trapiche* was purchased from Pimentel by Juan Duran in the 1650s (Galaor et al. 1998:147). It was then expanded it into a larger *ingenio* during the 1660s and was still in use one-hundred years later (Galaor et al. 1998).

4.5.3 **Asiruni el Chico Refinery**

Another early *trapiche* in the Puno Bay was called Asiruni el Chico (not to be confused with Gaspar de Salcedo's San Antonio de Asiruni refineries), likely owned by Pimentel as well. Sometime between 1644 and 1651, there was a legal dispute between Antonio Pimentel and two local indigenous *curacas* (lords) of the San Juan de Puno *reducción:* Don Juan Gómez Hilassaca and Xptobal Marca. This dispute was over the original ownership of a refinery located on indigenous grazing lands in the Puno Bay (ARP ibid.: folio 12-22).

In the dispute, the Puno *curacas* claimed that their land was being used for Spanish-owned *trapiches*. In this dispute, they list the following lands as belonging to their native community: 1) the Marcavana *majada* and *estancia*; 2) the Puchubio *majada*; 3) the Punopampa grazing lands; 4) the Paracaracauria *majada*; and 5) the Asiruni el Chico *majada* (ARP ibid.: folio 16-17). *Majada* referrers to rural and isolated corrals and animal holds used by shepherds to care for livestock, while *estancia* is estate land.

Within the discussion of indigenous grazing lands, the locations of the Asiruni el Chico lands are described as being near a small hill with a prehispanic burial tower called "Mayco Amaya." In these documents, a *trapiche* is mentioned as being located near to and above the Mayco Amaya funerary tower:

> *...hay desde la lomilla llamada Mayco Amaya donde esta una sepultura antigua que viene a dar por la parte de arriba yendo de este trapiche hacia la estancia de Marca Vana (ARP ibid.: folio 17-18).*

> …there is, from the small hill named Mayco Amaya, where there is an ancient burial tower that is located near the top of the hill, a *trapiche* on the way towards the Marca Vana estate (ARP ibid.: folio 17-18. English translation my own).

The "Mayco Amaya" hilltop is likely the location of the modern town of Malcomayo. The various spellings of Malcomayo originate from the Aymara language word for "Mayku Amaya," which translates to dead leader (*mayku* = leader; *amaya* = dead). This corresponds to the known location of a prehispanic burial tower of an important lord near the site (Figure 4.51).

I identified two silver refineries near the town of Malcomayo in 2017: Trapiche Itapalluni and an unnamed, smaller refinery (Figure 4.52). They both sit near the prehispanic burial tower located 1 km west of Malcomayo. Trapiche is located 2.5 km north of Malcomayo, while the unnamed refinery is less than 1 km west of Malcomayo. The reference to a *trapiche* on the Asiruni el Chico lands may refer to either Trapiche or the smaller refinery. The dates described in the archival documents for the Asiruni el Chico refinery were between 1644 and 1651, and they fit the radiocarbon dates from excavations at Trapiche (see Chapter 8).

Figure 4.51: The Malcomayo funerary tower, on the outskirts of the town of Malcomayo.

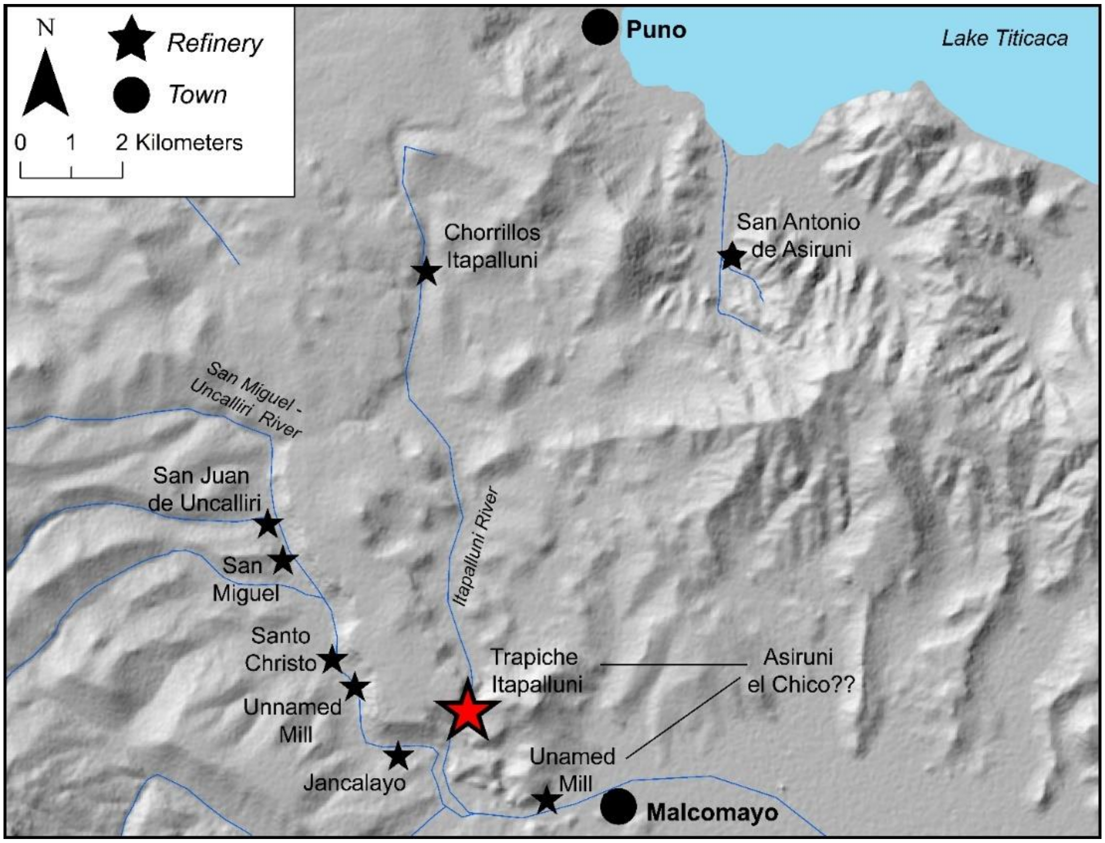

Figure 4.52: Map of the silver refineries south of Puno and the Laicacota and Cancharani Mines. The possible location of the Asiruni el Chico refinery is indicated here.

4.5.4 Cairani Refinery

Gaspar's brother, Joseph de Salcedo, also owned a refinery in the Puno Bay during the early 17th century. The *ingenio* was called Cairani and it was located some 5 leagues west of Puno (25 km) in the district of Tiquillaca (Domínguez 2006:312). Joseph acquired this *ingenio* sometime before 1661 and purchased it from a deceased debtor who owed him 80,000 pesos (AGI EC, leg. 565-B, cuad. 27, no 2, fol. 15v; Dodge 1984:85-86). We do not know who owned the refinery before Joseph, but we can assume Joseph de Salcedo was using it to refine silver by the 1650s, leading up to his discovery of Laicacota in 1657.

While this refinery was not located during my 2017 and 2018 fieldwork, a colonial archaeology site with the same name (Hacienda Cayrani) was identified in a survey by Elizabeth Arkush in the same general region, south of the town of Tiquillaca (Arkush 2011). While there were no grinding stones visible on the surface, the site included colonial architecture and pottery, and was located next to a river (Arkush, personal communication). This is very likely the same refinery used by Joseph de Salcedo in the 1650s and 1660s.

4.5.5 **The Ribera Uncalliri**

Following the discovery of the Laicacota mine in 1657, there were few, if any, new silver refinery constructions. This is likely a result of the ensuing conflict, which halted silver production in the region. I noted in Chapter 3 that Antonio López de Quiroga was entrusted with rehabilitating the Laicacota mines between 1669-1689, but I found no mention of new refineries during this period (Galaor et al. 1998:134). Likely, López de Quiroga used existing refineries, such as San Antonio de Asiruni and Cairani, to refine his silver, as the Salcedo brothers' descendants filed numerous petitions to reclaim ownership of these silver refineries throughout the 18th century.

In the 1740s, the Puno Bay experienced a second boom in silver production at the Cancharani mine. In conjunction with this boom, several silver refineries (Figure 4.53) were built south of Cancharani on the San Miguel/Uncalliri River, near the location of the San Juan *trapiche* built by Antonio Pimentel 100 years earlier (Galaor et al. 1998; JHL *Alegato jurídico* 1754, folios 1-21). This area became known as the "Ribera de Uncalliri." The use of the word *ribera* (shoreline) in conjunction with the presence of silver refineries was very common at this time, as San Antonio de Esquilache and Potosí both had their own *riberas* of refineries along the shores nearby large, powerful rivers. The Ribera Uncalliri was the Puno Bay's equivalent during the 18th century.

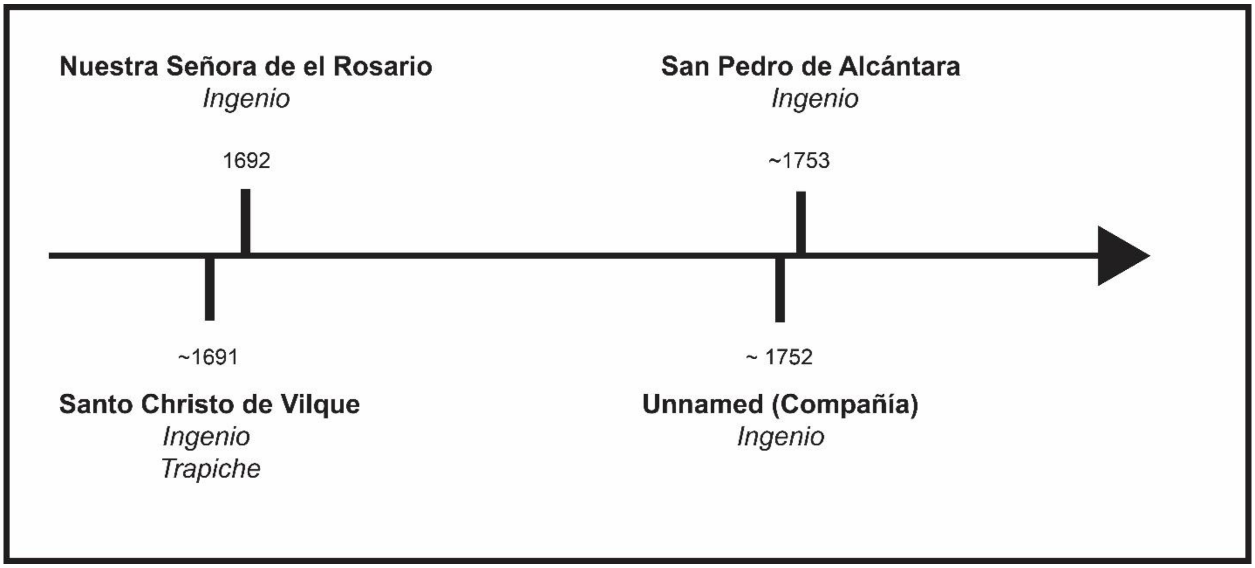

Figure 4.53: Timeline of refineries built in the Puno Bay after the Laicacota silver boom in the 1660s. Note all but one of these is an ingenio.

4.5.6 Santo Christo de Vilque Refinery

One of the earliest *ingenio* refineries built on the Ribera de Uncalliri was Santo Christo de Vilque (JHL, *Alegato jurídico* 1754, folios 1-21). It was built around 1691 by Joseph Duran, a likely relative of Juan Duran, who purchased the San Juan refinery from Pimentel 40 years earlier. It is unknown how frequently Santo Christo de Vilque was in use during the 60 years preceding the Cancharani boom, but by 1754 ownership of both an *ingenio* and *trapiche* at the site was a hotly disputed matter (JHL ibid:11v). Descendants of the Salcedo brothers claimed ownership of the refineries, while members of a local mining company argued they had legally purchased them from Don Joseph de Sanrroman:

> *Y por no dexar nada en el tintero la malicia de el Marqués dize, que tiene entendido, aunque no con la evidencia, que se requiere, que la Compañía compró a Doña Maria Theresa Tenaquero, un ingenio, y ciertos intereses en Laicacota, y Cancharani, y como Doña Maria Theresa fue albacea de Don Joseph de Sanrroman y este de el primer Marqués arguye, que el Ingenio vendido fue de su Padre, y que por la ocultación de papeles ha*

querido hazerle dueño Doña Maria Theresa. …El Ingenio, y Trapiche, que la Compañía compró a Dona Maria Theresa es el llamando el Santo Christo de Vilque en la rivera de Vncalliri. [No discurra el Marqués, que por que su Padre puso por nombre a la Veta que descubrió el Santo Christo de Vilque es lo mismo esta Veta que el Ingenio, y por esso pretenda derecho a el. No lo piense, que son dos cossas muy distintas]. Fabrico a sus expensas este Ingenio Joseph Duran, Minero, y azoguero en la Provincia de Paucarcolla, precidiendo para ello licencia, que se le concedió por este Superior Gobierno en 22 de octubre de el año passado de 1691 (JHL ibid:11v-12r).

> And leaving nothing left unsaid, while, with malice, the Marquis states, that he has understood, although not with evidence, which is required, that the Company bought an *ingenio* from Doña Maria Theresa Tenaquero, as well as certain mining claims on Laicacota and Cancharani, and as Doña Maria Theresa was the executor of Don Joseph de Sanrroman's will and property, and this is what the first Marquis argues, that the *ingenio* sold was actually his father's, and through the concealment of papers, Doña Maria Theresa wanted to make Joseph de Sanrroman the owner instead...The *ingenio*, and *trapiche,* that the Company bought from Doña Maria Theresa, is named Santo Christo de Vilque and is located on the Vncalliri river. [Do not be tricked by the Marquis's argument, which states that because his father's mining vein was also called "Santo Christo de Vilque," that the *ingenio* with the same name also belongs to him. Do not believe it, these are two very different things]. In actuality, Joseph Duran, mine and refinery owner of the province of Paucarcolla, built this *ingenio* his own expense, and obtained a license for it, which was granted by this Superior Government on October 22 of the last year of 1691 (JHL ibid: 11v-12r. English translation and italics my own).

It is likely the Santo Christo de Vilque refinery is the same refinery as Santo Cristo, which I located during my 2017 season. The 1754 petition for ownership of the refinery was filed during the height of the Cancharani boom, when ownership of the refinery would have become very important. The control of the Salcedo family appears to have been waning by this time, as larger collections of individuals within mining companies were gaining power in the Puno Bay (JHL, *Alegato jurídico* 1754, folios 1-21).

4.5.7 **Unnamed/Compañía Ingenio**

The Ribera de Uncalliri is described in detail in a 1752 mining survey for the Spanish national museum, the Real Gabinete de Historical Natural de Madrid (Galaor et al. 1998). The report from Puno, recorded in 1753, describes mining operations at the Cancharani mine and the process of ore extraction is discussed in detail (see Chapter 2). The report also mentions how the Cancharani ore was taken to be processed at an unnamed *ingenio* on the Ribera de Uncalliri:

> *Después [de] que [los metales] se sacan de la mina…. se manda secar desmenuzada y limpia de cada cosa. Estos, en sus cases, se carga[n] en cameros de la tierra al ingenio, que tiene distante tres leguas [de Cancharani], en la rivera de Uncalliri, llamado el de la Compañía, que compraron a su legítimo dueño por la cantidad de 11000 pesos, su intrínseco valor, con aprobación del superior gobierno de estos reinos (Galaor et al. 1998:144)*

> After the silver ore is removed from the mine…it is sent to be dried and be cleaned. The ore, in its cases, is loaded in *cameros* from the mine to the *ingenio*, which is three leagues [from Cancharani], on the Uncalliri river, the one named for the Company, which they bought from the rightful owner for the amount 11,000 pesos, its intrinsic value, with the approval of the superior government of these kingdoms (Galaor et al. 1998:144. English translation and italics my own)

In the report, the name of the *ingenio* is not provided, only that it was "named for the Company" of mine prospectors who also owned the Santa Cruz vein at the Cancharani mine (Galaor et al. 1998:142-143). This *ingenio* was purchased for 11,000 pesos around 1752 and was located three leagues (~12 km) from the mine. This puts its supposed location near Trapiche Itapalluni (11 km from Cancharani) and the unnamed refinery (12 km), both discussed as possible locations of the Asiruni el Chico refinery. While Trapiche sits on the Itapalluni River, the unnamed mill is located on the San Miguel/Uncalliri River and may be this exact refinery. The other refineries on the Ribera de Uncalliri sit closer to Cancharani (Santo Cristo, 9 km; San Miguel, 9 km; San Juan, 8 km; Chorrillos, 4 km).

4.5.8 **San Pedro de Alcántara Refinery**

Another *ingenio* discussed in the 1752 report was called San Pedro de Alcántara. It was apparently worked by the *azoguero* and *dueño de minas* Don Silvestre de las Cuentas (Galaor et al. 1998:148). Don Silvestre owned mining claims at Laicacota la Alta mine in 1753 and refined his ore at both the San Pedro de Alcántara refinery, as well as the Itapalluni refinery (likely Chorrillos Itapalluni). He was not, however, the owner of either refinery. Instead, he leased the *ingenios* from Doña Marcelina de Valverde y Perales to refine his silver ore. The 1753 mining report details this relationship in the following way:

> *En la citada veta de Santa Teresa, Laicacota la Alta, se halla trabajando actualmente don Silvestre de las Cuentas, azoguero y dueño del ingenio de Itapalluni, en las minas viejas, que le pertenece (a dicho ingenio y al de San Pedro de Alcántara en la ribera de Uncalliri, proprio de dona Marcelina de Valverde y Perales) y tuvo desde la antigüedad, limpiando y habilitando los derrumbes y comidos antiguos, con el fin de llegar y penetrar a los planes de la profundidad y agua… (Galaor et al. 1998:148).*
>
> In the aforementioned silver vein of Santa Teresa, at Laicacota la Alta, the owner of the Itapalluni *ingenio,* Don Silvestre de las Cuentas, is currently working old mining veins, which belong to him, (the said *ingenio*, and the *ingenio* San Pedro de Alcántara, on the Uncalliri river, are located on the property of Doña Marcelina de Valverde y Perales) and he has worked these veins since antiquity, cleaning and maintaining the landslides and old services, in order to reach and penetrate the depth and water of the mines… (Galaor et al. 1998: 148. English translation and italics my own).

According to the report, Silvestre de las Cuentas rented two *ingenio* refineries to process his Laicacota ore: Chorrillos and San Pedro de Alcántara. The San Pedro de Alcántara *ingenio* was located on the Ribera de Uncalliri and may have been the site that is known today as San Miguel, just south of the San Juan refinery. By the mid-19th century, there was apparently a still-functioning *trapiche* named San Miguel about 3 leagues (12 km) from Puno, in this general region (Rivero y Ustáriz 1857:29). The site may have been renamed following the conversion of the main mill into a chapel in 1804.

4.5.9 **Nuestra Señora del Rosario Refinery**

One of the final documented Puno Bay refineries in use during the 1750's was called the Nuestra Señora del Rosario *ingenio*, although it is unclear where it was actually physically located (JHL, *Alegato jurídico* 1754, folios 1-21). This refinery originally belonged to Gaspar de Salcedo as far back as 1692, and he describes all of his possessions left inside the *ingenio* in his last will and testament (see Chapter 2) (Hurtado Chávez 2008:38-39; Frisancho Pineda 1996:81-87). However, I have not been able to find geographical references to this refinery.

By 1712, the refinery had passed into the hands of Gaspar's nephew, the first Marques de Villa-Rica de Salcedo, José Salcedo. In 1712, the Marques sold the refinery, and its accompanying mines, to Gaspar de Salcedo "el Mozo," or "the Younger," likely Gaspar's son. Around 40 years later, the Salcedo family again faced charges of unlawful ownership of this refinery, and defended themselves in a 1754 claim:

> *Y por otro instrumento, que en la misma conformidad presento num. 28 consta, que el primer Marques por ante Vicente Muñoz Marueño Escribano público, que fue, en 10 de Abril de 1712, dio en venta real a Gaspar de Salcedo el mozo un ingenio nombrado Nuestra Señora de el Rosario, en la jurisdicción de Puno, las minas e intereses, que tenía, y Socavón Real en el mineral de Laicacota la alta, que hubo, y compro de los Licenciados, Don Juan Joseph Tiburcio y Don Phelipe Ramírez de Ayala, cuya venta hizo en 2500 pesos (JHL ibid:20v).*
>
> And by another legal document, that in similar accordance with claim number 28, which I have presented, the first Marquis, who states in front of Vicente Muñoz Marueño, a public notary, that on April 10, 1712 he sold an *ingenio* named Our Lady of the Rosary located in the jurisdiction of Puno to Gaspar de Salcedo "the Younger," as well as all of his mining interests, mine shafts, and tunnels, including the Royal Mine of *Laicacota la Alta*, where it was located, and that he bought from the *Licenciados*, Don Juan Joseph Tiburcio and Don Phelipe Ramírez de Ayala, which originally sold for 2,500 pesos (JHL ibid: 20v. English translation and italics my own).

While I cannot locate the exact location of the Nuestra Señora del Rosario refinery, it is obvious that by the 1750s, the Salcedo family was facing an unprecedented array of legal disputes calling into question their ownership and authority of silver refineries in the Puno region.

4.6 Connecting Refineries to the Documents

Through the location and identification of at least ten different *ingenio* and *trapiche* silver refineries in the Puno Bay, I have charted the change in ownership of the silver refining industry throughout the 17th and 18th centuries (Table 4.1, Figure 4.54). Ownership and control of silver refineries changed dramatically over time, as total control by a few individuals broke down by the Cancharani silver boom of the mid-18th century. This is visible in changes in ownership of the silver refineries, as well as the increase in disputes over refinery ownership.

Table 4.1: Silver Refineries of the Puno Bay.

Year Built	Historical Name	Site Name	Type	1st Owner	2nd Owner	3rd Owner	4th Owner
1644	San Antonio de Asiruni	Salcedo	Trapiche	Antonio Pimentel	Gaspar de Salcedo		
1644-1651	San Juan de Uncalliri	San Juan	Trapiche	Antonio Pimentel	Juan Duran		
1646	Asiruni el Chico	Trapiche Itapalluni?	Trapiche	Antonio Pimentel			
1654	San Antonio de Asiruni	Salcedo	Ingenio	Gaspar de Salcedo			
1660	Cairani	Hacienda Cayrani	Ingenio	Joseph de Salcedo			
1691	Santo Christo de Vilque	Santo Cristo	Ingenio	Joseph Duran	Joseph de Sanrroman	A company	
1692	Nuestra Señora del Rosario	-	Ingenio	Gaspar de Salcedo	Marqués de Villa-Rica de Salcedo	Gaspar el Mozo	A company
1752	Unnamed/ Compañía	Unnamed Mill	Ingenio	A company			
1753	San Pedro de Alcántara	San Miguel?	Ingenio	Silvestre de las Cuentas			
1754	Santo Christo de Vilque	Santo Cristo	Trapiche	A company			

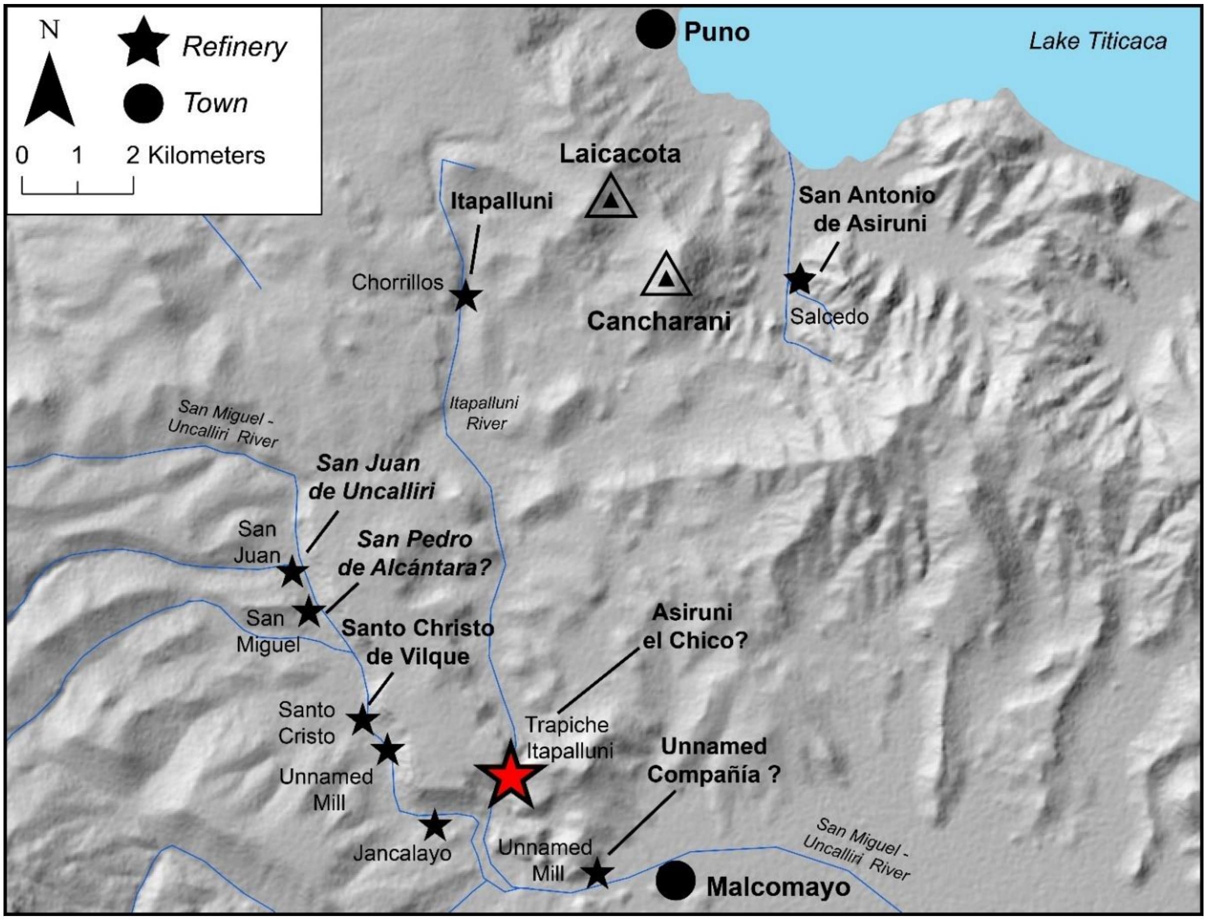

Figure 4.54: Location of the Puno Bay refineries, with both historical and archaeological site names. Historical names are in bold.

Prior to the Laicacota silver boom in 1657, the archival documents describe at least five silver refineries controlled by only three Spanish men (Antonio Pimentel, and the brothers Gaspar and Joseph de Salcedo): the San Antonio de Asiruni *trapiche* (Pimentel/Gaspar de Salcedo); the San Juan *trapiche* (Pimentel); the Asiruni el Chico *trapiche* (Pimentel); the San Antonio de Asiruni *ingenio* (Gaspar de Salcedo); and the Cairani *ingenio* (Joseph de Salcedo).

Of these men, two of them, captain Antonio Pimentel and captain Gaspar de Salcedo, were military men and soldiers in the Spanish military. Their positions as soldiers were likely responsible for their early capital and acquirement of the silver refineries. They also owned silver veins at the silver mines of San Jose and San Antonio de Esquilache.

Ownership and control of the Puno Bay refineries during the 18th century was markedly different than the 17th century. The only silver refinery still in possession of the Salcedo family in the 18th century was the Nuestra Señora del Rosario refinery, owned by Gaspar el Mozo. However, it was featured in the Lima 1754 legal petition levied against the Salcedos, where a collection of individuals in an unnamed mining company petitioned for the ownership and control of a series of mines and refineries in the Puno region, including the Nuestra Señora del Rosario refinery. The other 18th century Puno Bay refineries I documented belonged to either a collection of individuals, or a company of individuals. This is much different than the early vertical integration and control of the silver production chain that occurred in the 1660s.

4.7 Summary

This chapter included a summary of historical and architectural analyses conducted on silver refineries in the Puno Bay during the 17th and 18th centuries. It used archival data to track silver refining in the Puno Bay in the 17th and 18th centuries, identifying at least five silver refineries in operation in Puno *before* the Laicacota boom of 1657. The chapter also identifies at least eight refineries in operation in the area during the second silver boom at Cancharani, in the 18th century. By tracking ownership of these refineries over two centuries, this chapter argues that control of silver refineries changed throughout the colonial period in the Puno Bay, as total control of the production chain by one or two individuals breaks down and becomes less integrated by the Cancharani boom of the 18th century. Control ends up in the hands of multiple companies of individuals during this period.

5.0 Space Syntax Analysis of Three Puno Bay Refineries

5.1 Introduction

This chapter examines the spatial layout of three colonial silver refineries located in the Puno Bay of the western Lake Titicaca Basin of southern Peru: Chorrillos Itapalluni (“Chorrillos”), Santo Cristo, and Trapiche Itapalluni (“Trapiche”). These three sites are introduced and described in more detail in the preceding chapter (Chapter 4). They sit on the Itapalluni and San Miguel rivers approximately 10-15 km south of the city of Puno in the western Lake Titicaca Basin of southern Peru and they were operated throughout the colonial period (~1600-1800 AD).

In this chapter, I present a spatial analysis of these three sites using aerial data gathered from drone mapping conducted in 2017 and 2018. Spatial syntax analysis was performed using the drone maps to systematically analyze the spatial layout of these sites, specifically addressing: 1) what were common characteristics of refinery spaces? 2) how restricted were certain areas within these refineries? and 3) how do the three sites compare?

The analysis uses qualitative and quantitative spatial techniques to evaluate the degree of control and access at the sites. Focus is on the location of dwellings, administrative patios, and entrances and exits to examine at how spaces were accessed, restricted, and regulated. Results indicate the presence of restricted and segregated areas at all three refineries. However, comparison between the three refineries highlights the especially segregated and controlled nature of Chorrillos, in contrast to the more open layout of Trapiche and Santo Cristo. Following this analysis, Trapiche was chosen for further investigations (Chapters 6-9). Portions of this chapter have already been presented to the general public (Kennedy 2018, 2019).

5.2 Space Syntax Methodology

A space syntax analysis was conducted to further explore the nature of space within Chorrillos, Santo Cristo, and Trapiche (see Moore 1996 for another Andean example of space syntax applied to architecture at Chan Chan). This type of analysis was utilized because each site had above-ground architecture and we were given permission from landowners to conduct architectural survey and drone mapping at these three sites. The orthomosaic drone maps of these sites presented and discussed in Chapter 4, along with field notes marking the presence and location of doorways, were used to construct building plans for each refinery. These building plans were uploaded into the software program Jass, a simple Java program designed specifically for space syntax, to complete the analysis. Each room at each refinery was assigned a "node", and doorways were depicted as lines or "links."

Chorrillos, for example, was assigned 62 total nodes, or spaces, including the area outside of the site (Figure 5.1). Each node was connected to accessible rooms with links, as well as to the outside entrance to the site. For example, Chorrillos has only one principal entrance located in the northeast corner of the site, which was marked. It also had a separate entrance into the southwest sector of the refinery, which connected to the outside.

A justified permeability graph was produced for all sites, visually depicting the accessibility of different spaces from the outside (again, see Figure 5.1). This technique requires choosing a door from which the building complex is entered. The outside area becomes the exterior vertex, or carrier, while the entrance door becomes the edge connecting the exterior vertex with the vertex of the first room entered (Neiman 2005). This is visible in Chorrillos's permeability graph, as the outside, or carrier, is shown at the bottom of the graph, connecting to its adjoining rooms by further edges, or doorways. Each room at the sites was assigned a depth, which is the number of edges, or doors, one crosses as they travel along the *shortest possible path* from the carrier to the room in question (Neiman 2005:2-3). Rooms with equal depth are aligned horizontally, while rooms on successively higher levels represent greater depth.

Additional spatial analyses were conducted from within the Jass program, including measures of connectivity, control, total depth, mean depth, and relative asymmetry. Connectivity of a single room refers to the number of doorways into that room. Connectivity analyses assessed connections with a single link (counting nodes/rooms that were immediately connected to an individual room), as well as with two links (counting the number of nodes/rooms connected within two links). Control is a measure of how much a given room controls access to immediately adjacent rooms (rooms immediately connected by doorways). The control value is usually inversely proportional to the connectivity of adjacent rooms. Control for a specific room is calculated by multiplying its adjacency vector by the reciprocal of the connectivity values for all the rooms and summing the product (Neiman 2005:4).

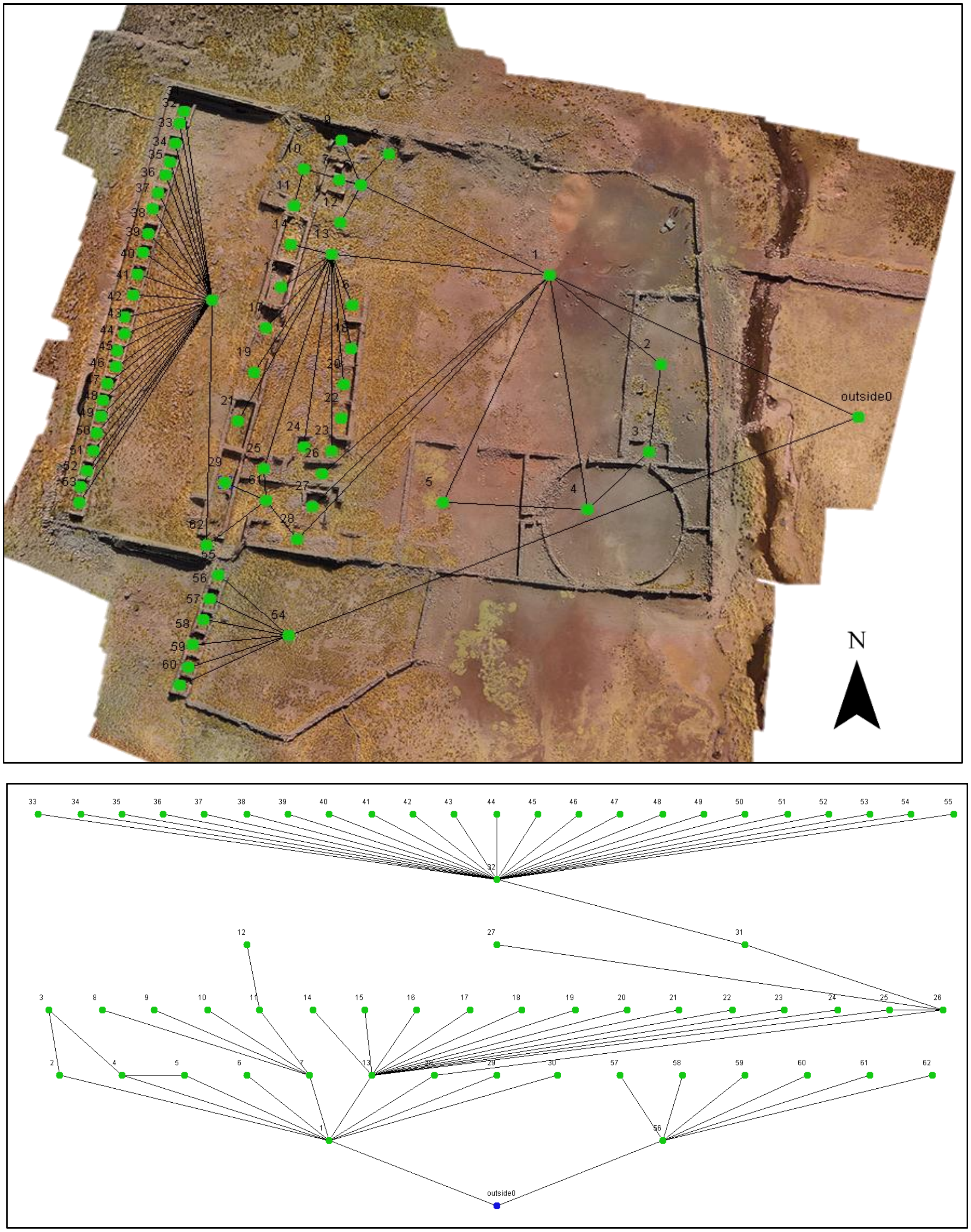

Figure 5.1: Space syntax analysis of Chorrillos. (Top) the location of nodes and links, and (Bottom) the justified permeability graph depicting site depth.

Total depth, mean depth, and relative asymmetry were also calculated for each site, which are all measures used to assess the overall integration of a site or building complex. Integration is a broad assessment of overall site depth, but instead of calculating depth from a single carrier, depth of a room is calculated by counting the number of edges (doorways) along *the shortest path* between rooms (Neiman 2005:5). Total depth for a room is thus the sum of the depths from all other rooms. Mean depth for a room is its total depth divided by the total number of rooms, minus one for the room whose depth is being calculated. Rooms with lower mean depths tend to be more integrated with the rest of the site. Relative asymmetry is a normalized function of mean depth, relative to the minimum and maximum mean depths and the observed vertices (Neiman 2005:5).

To show the results of the space syntax visually from within ArcGIS, I used ArcMap to draw separate polygons over each of my designated "nodes" or spaces in each refinery. I drew them in the same order I labeled the nodes from within Jass, so that when I chose "convert graphics to features," my shapefile's attribute table listed the polygons with the correct field identification number (FID). I used the "drawing" function on all three sites and produced polygon shapefiles of designated spaces in this manner (Figure 5.2). After I completed drawing the shapefile polygons, I joined the excel tables with space syntax information to each site's corresponding shapefile. This join allowed me to visually represent my results through the symbology tab, where I was able to choose different space syntax measures to depicted spatially across the site.

Figure 5.2: Designated spaces at Chorrillos, showing different rooms.

5.3 Chorrillos Space Syntax

I began the space syntax analysis focusing on the site of Chorrillos, which was the largest of the three sites with 62 distinct spaces. Chorrillos was a larger ore-processing site occupied for at least two centuries (see Chapter 4 for more detail). Preliminary results of the space syntax analysis revealed strong differences in access and control within the site. While the site itself is not overly deep (only 6 levels), the cell-like dormitories on the western side of the site have the highest depth values (Figure 5.3). To access these structures, one would have had to pass through five separate, additional rooms. If these spaces were indeed dormitories for indigenous laborers, they were in the deepest sector of the site, furthest from the main entrance.

A connectivity analysis was also performed in which doorways, or links, between each individual room were counted (Figure 5.4). This analysis revealed central areas of Chorrillos, such as the eastern, central, and western patio areas. While each of these patio spaces had high connectivity values, they appear to have functioned quite differently. The eastern patio was most likely a large work area associated with the grinding and processing of ore by *mitayo* laborers. The central patio was associated with larger, Spanish-style buildings. This area may have been administrational in function, and doorways of the buildings surrounding the central patio only open inwards, reflecting its closed and private nature. The western patio immediately connects the western structures to the rest of the site. This patio's function may have been for both the refining and domestic tasks of indigenous laborers.

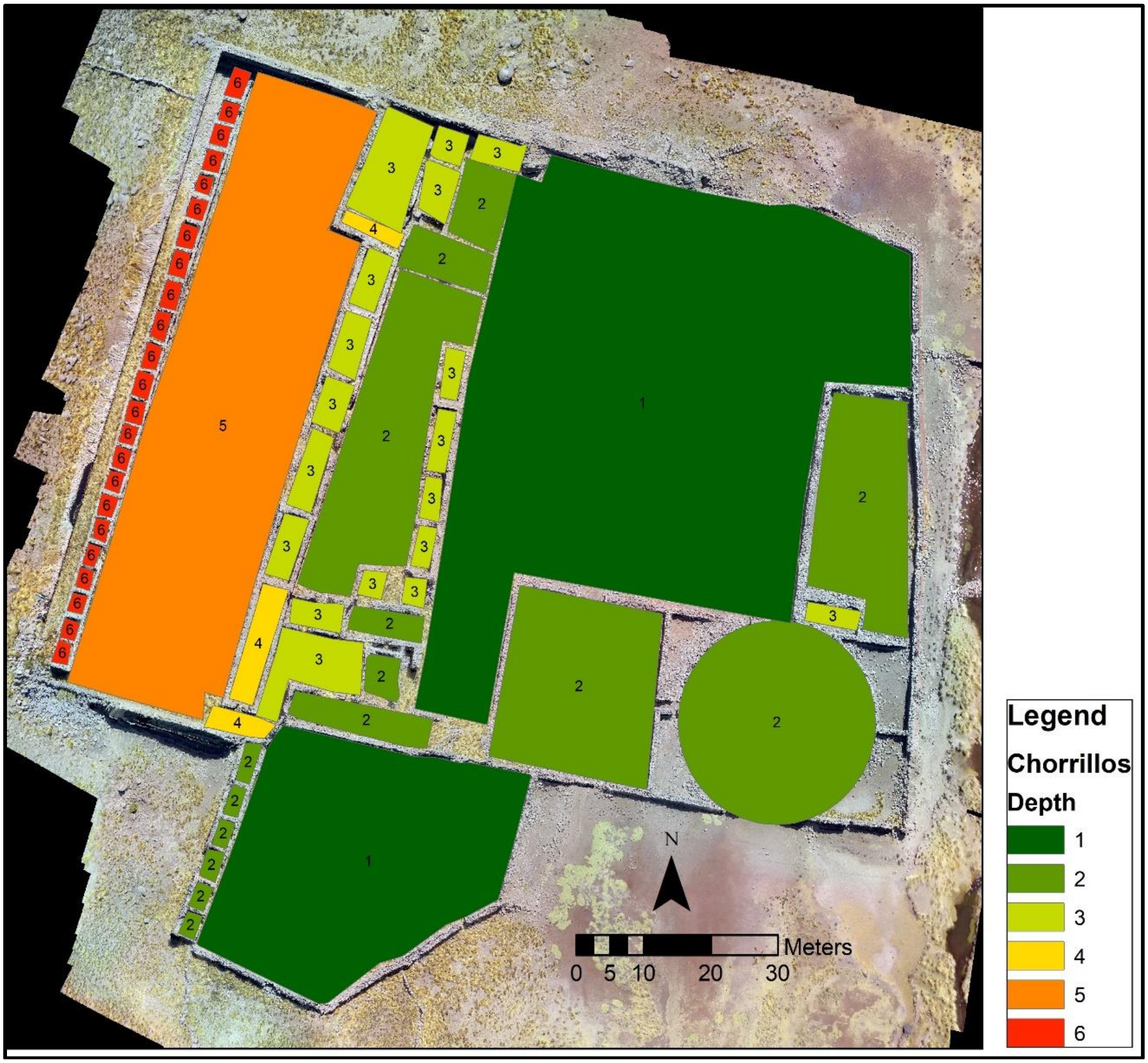

Figure 5.3: Depth of rooms at Chorrillos.

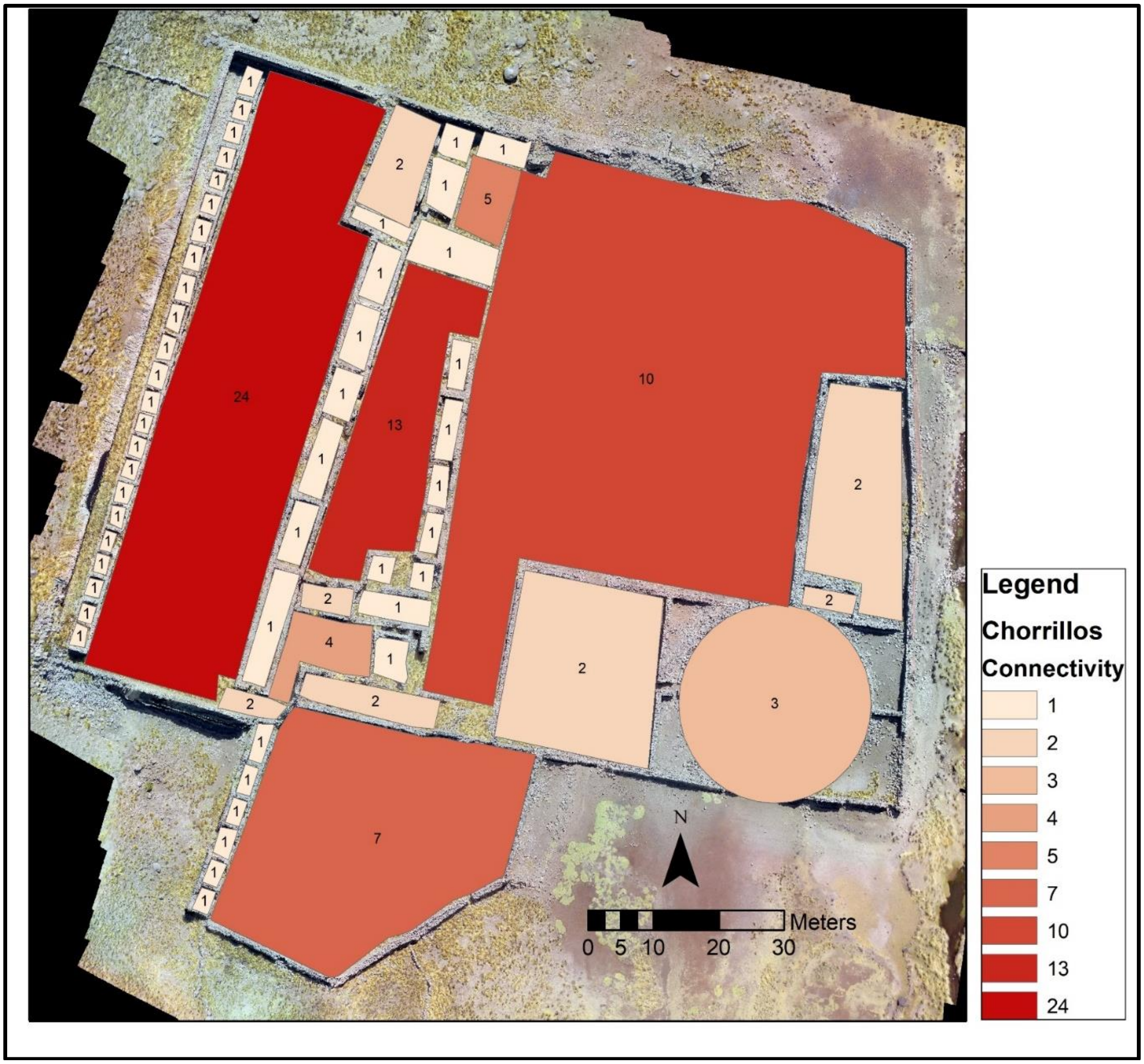

Figure 5.4: Connectivity with one link at Chorrillos.

Control was calculated to determine access across the site, highlighting areas that controlled paths going in and out of certain areas. Spaces with higher control values indicate areas of stronger spatial control. At Chorrillos, the location of strongest control was the western patio, controlling access to the western structures (Figure 5.5). The other control point was the central patio, which controlled access to the Spanish-style administrative buildings. Control values indicate these two areas functioned as strong points of control, and managed access to the buildings immediately adjacent to their spaces. In contrast, the eastern patio had a much lower control value (5.6) and was probably less likely to exert strong control of movement in and out of its space.

Integration and segregation of areas within Chorrillos were also assessed through the measures of mean depth and relative asymmetry. Mean depth calculations revealed areas of both integration and segregation within the site (Figure 5.6). Larger values indicate longer paths needed to reach specific spaces, reflecting seclusion. This included the amalgamation area and the oven, as well as the western structures and the potential domestic structures of the southwestern sector.

Smaller mean depth values indicated shorter paths needed to reach the spaces, reflecting well-connected and integrated areas. These included the eastern and central patios, as well as the southern administrative buildings, including the potential chapel. The rooms with smaller mean depth values also appear to form an important area of travel and flow throughout the site. This path of travel goes directly to the potential chapel, replicating patterns of Spanish architecture found in similar spatial network analyses of colonial sites in the Andean highlands (Wernke 2012).

Relative asymmetry was also calculated to assess integration at Chorrillos (Figure 5.7). Relative asymmetry is the normalized value of mean depth, which is relative to the maximum and minimum mean depths within the present calculation. Higher values again indicated longer paths and secluded areas of the site, while lower values indicate shorter paths and more integrated areas of the site. Total relative asymmetry for Chorrillos was 62.21.

Similar patterns already visible in the mean depth calculations emerge, indicating that the oven in the amalgamation area, as well as the domestic structures in the southern area of the site, were the most secluded areas. These spaces were likely more restricted to certain individuals. In particular, the oven may have required specialized knowledge or skills and was probably only used by paid laborers and/or refining specialists.

The structures in the southwestern domestic area (Sector D) were also quite secluded and needed to be accessed from a separate entrance. This area may have been used by higher-ranking or higher-status individuals who lived in larger, separate living quarters, away from the noisy and dusty refinery tasks. Alternatively, this area may have been used to house transporters of ore (muleteers and owners of llamas used for caravans and trade). These individuals may have been kept apart, secluded from the indigenous laborers to control the illegal import and export of silver or mercury.

Figure 5.5: Control values at Chorrillos.

Figure 5.6: Mean depth at Chorrillos.

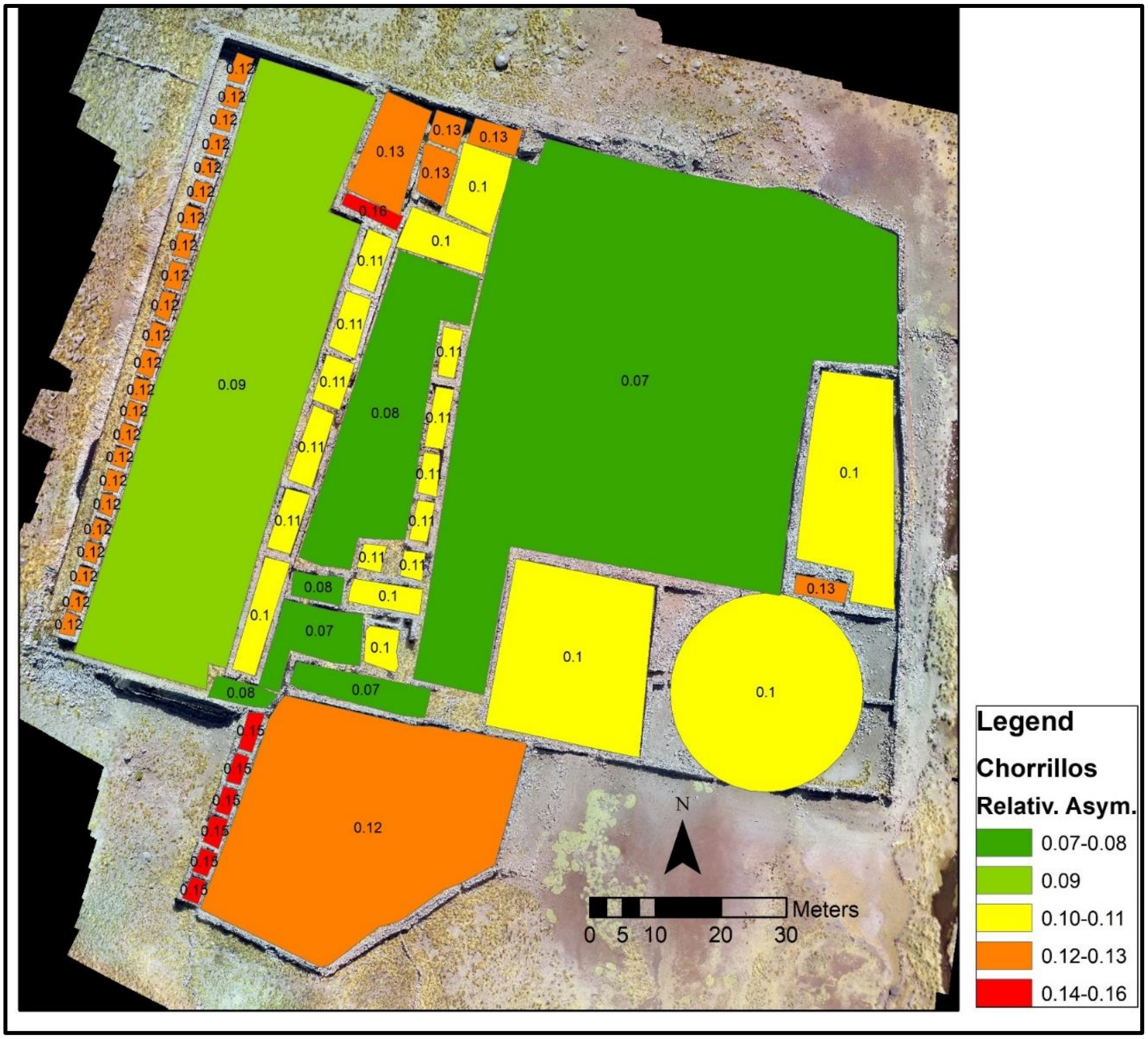

Figure 5.7: Relative asymmetry at Chorrillos.

5.4 Santo Cristo Space Syntax

Space syntax analysis was also conducted at the Santo Cristo refinery. In the colonial documents, Santo Cristo (named Santo Christo de Vilque) had both an *ingenio* and *trapiche* on site, revealing its varied nature of ore processing (see Chapter 4 for a more detailed discussion of the site). Site depth at Santo Cristo corresponded to the same level as Chorrillos (6 levels), although the spaces that were the deepest at Santo Cristo were likely used for firing and heating mercury and silver during the amalgamation process (Figure 5.8). Laborer dormitories were not found at Santo Cristo, although smaller rectangular structures (presumably used for storage) surrounded the central work patio. Some of these did have a depth level of 3, and may have been areas where important commodities, such as silver and mercury, were stored.

Mean depth analysis at Santo Cristo again revealed patterns similar to Chorrillos (Figure 5.9). Larger work patios were more accessible and integrated (lower mean depth). More restricted areas of Santo Cristo included silver refining areas, such as the principal grinding mill, as well as potential ovens and other refinery buildings. Administrative structures, which sat high on a hill on the northern edge of the site, were also areas of restricted access. These were likely domestic structures pertaining to the refinery owner and/or overseer, as they were placed in a beneficial position for surveillance of laborers, overlooking the patio and production area in the patios below.

Finally, relative asymmetry was calculated for Santo Cristo (Figure 5.10). These results more clearly define segregated areas at the site, which correspond to the grinding mill, amalgamation structures, and the administrative “Spanish-style” buildings. Total relative asymmetry for Santo Cristo was 37.12, much lower than Chorrillos (62.21), meaning the site was less segregated (and more integrated) than Chorrillos. Overall, it appears that control of movement throughout Santo Cristo was less pronounced than at Chorrillos, and this site may have been less regulated and less governed by an internal power hierarchy.

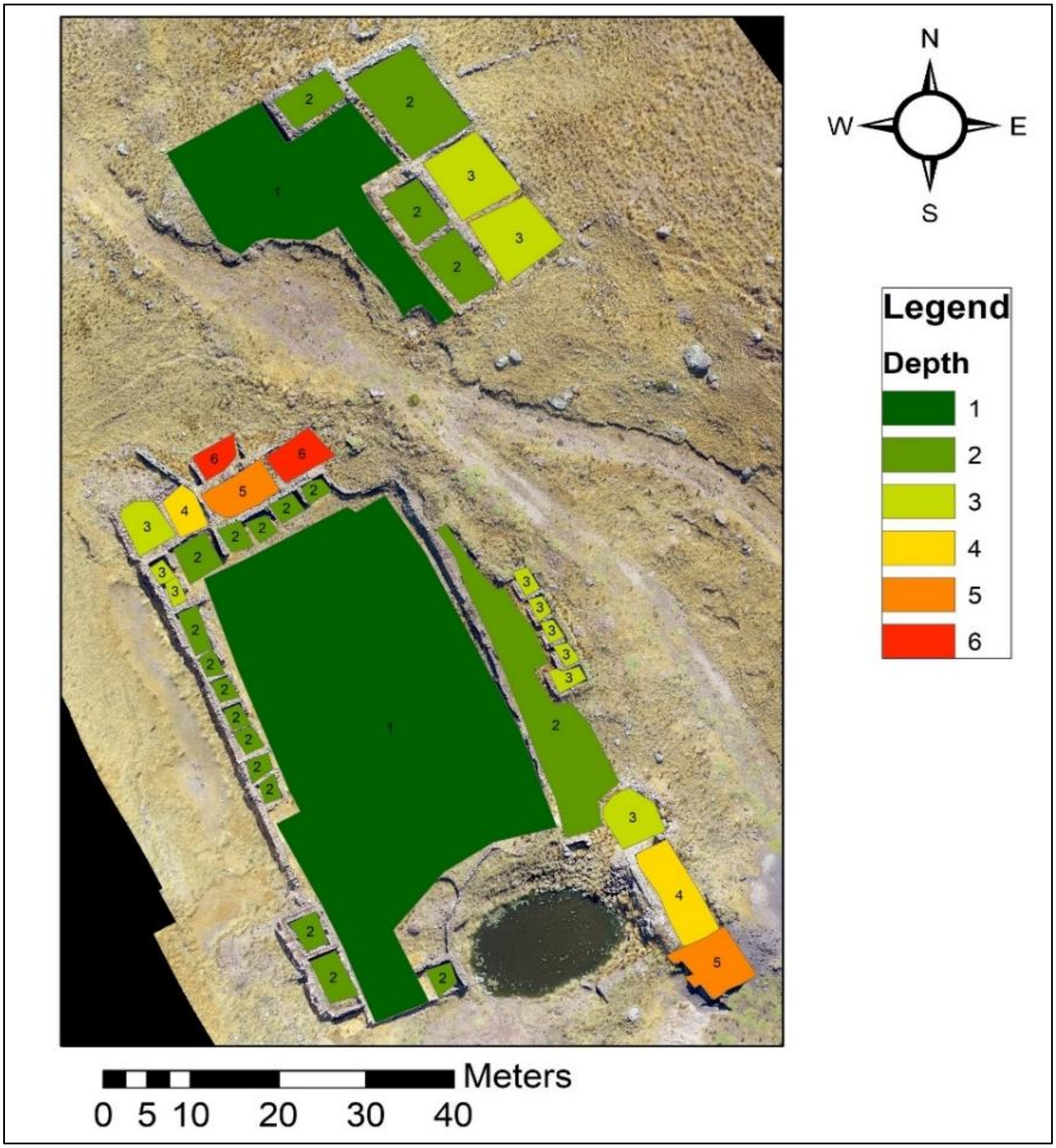

Figure 5.8: Depth of rooms at Santo Cristo.

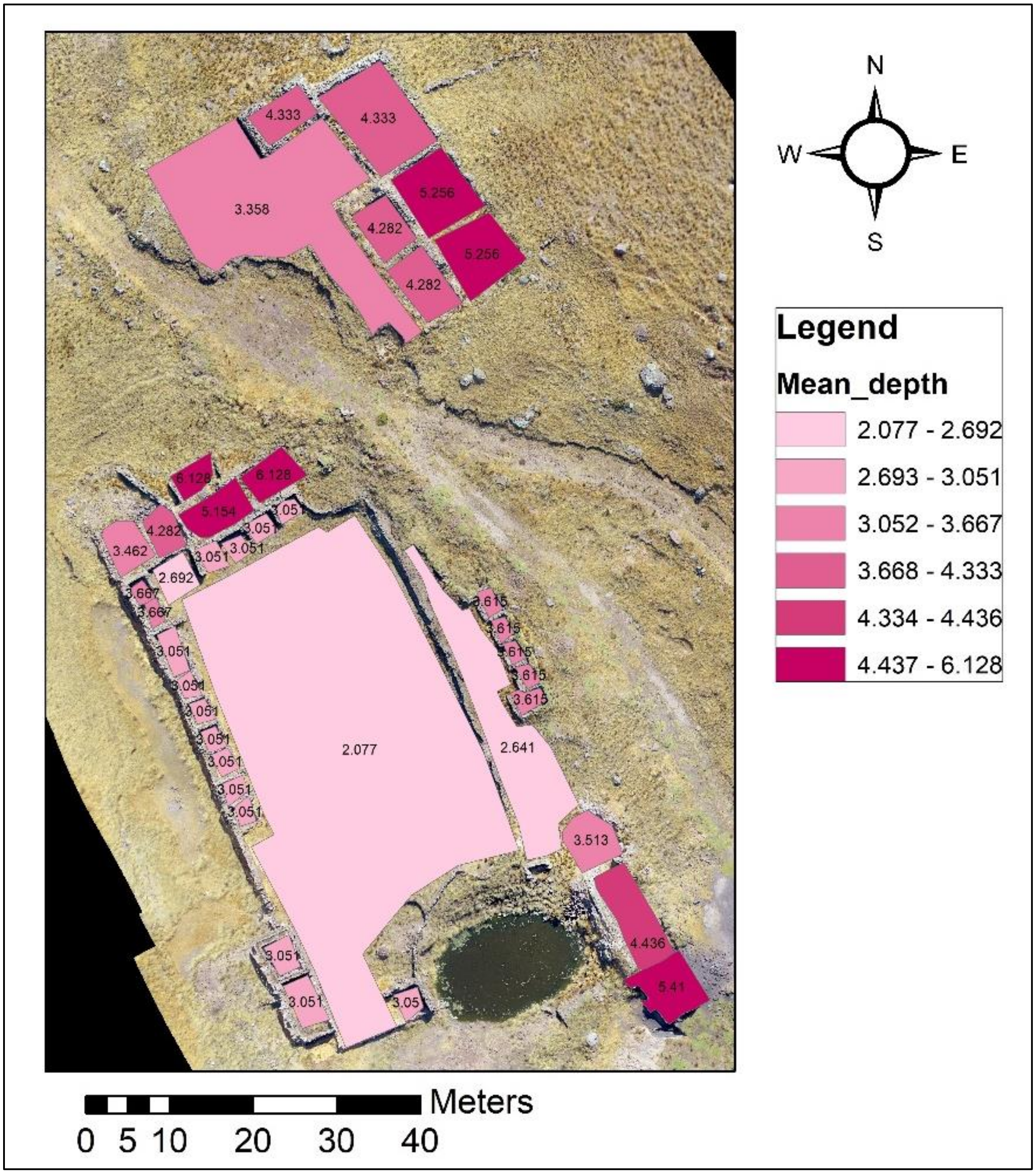

Figure 5.9: Mean depth at Santo Cristo.

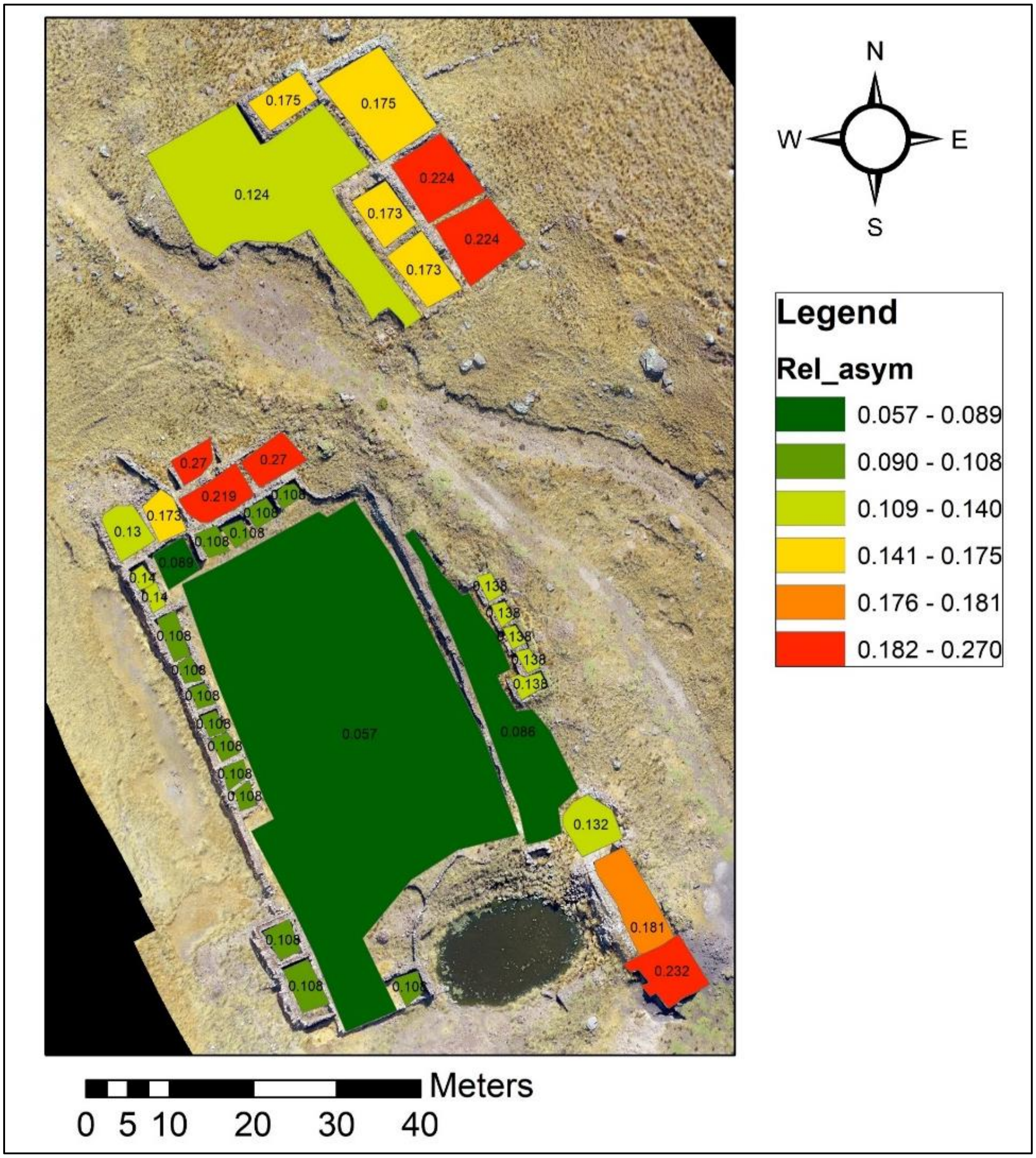

Figure 5.10: Relative asymmetry at Santo Cristo.

5.5 Trapiche Space Syntax

Trapiche was the deepest of all the sites with eight levels, due to its confined north/south layout with the Itapalluni River to the west and a high ridge located along its eastern edge (Figure 5.11). Movement throughout the site was funneled through a small, narrow area, and individuals would have had to pass through various patio areas to reach the northern and southern areas.

I chose to use the southern end of Trapiche as the principal entrance to the site, although it may have been possible to enter Trapiche from the north as well. The southern entrance was likely the main entrance as we found evidence for two colonial roads to the south of Trapiche (see Chapter 4). Structures at the southern end of the site appear to have once been used as an entrance into the refinery, strengthening our hypothesis that the site was entered primarily from the south. I also conducted space syntax analysis in both directions, and the results from a northern entrance are depicted in Appendix A. I only present the results from the southern entrance in this chapter, as I believe this was the most plausible entrance location.

The spaces with the highest depth at Trapiche were in the northern-most portion of the site, as the site entrance was likely located at the south end (Figure 5.12). The highest depth was the possible sentry or structure for the muleteers/transporters, located outside of the northern boundary of Trapiche. The laborer households were also harder to access (6-7 depth scores), similar to the western dormitory structures at the site of Chorrillos.

Mean depth at Trapiche revealed work patios to be the most accessible and integrated areas of the site, which follow similar results at Chorrillos and Santo Cristo (Figure 5.13). More restricted areas of Trapiche included the grinding mill, the northern outpost, the church and its adjacent buildings, and some administrative structures. Relative asymmetry revealed that the most segregated areas of Trapiche were the grinding mill, church, northern outpost, and one specific administrative building (Figure 5.14). Total relative asymmetry for Trapiche was 39.10, compared to Santo Cristo at 37.12, and Chorrillos at 62.21.

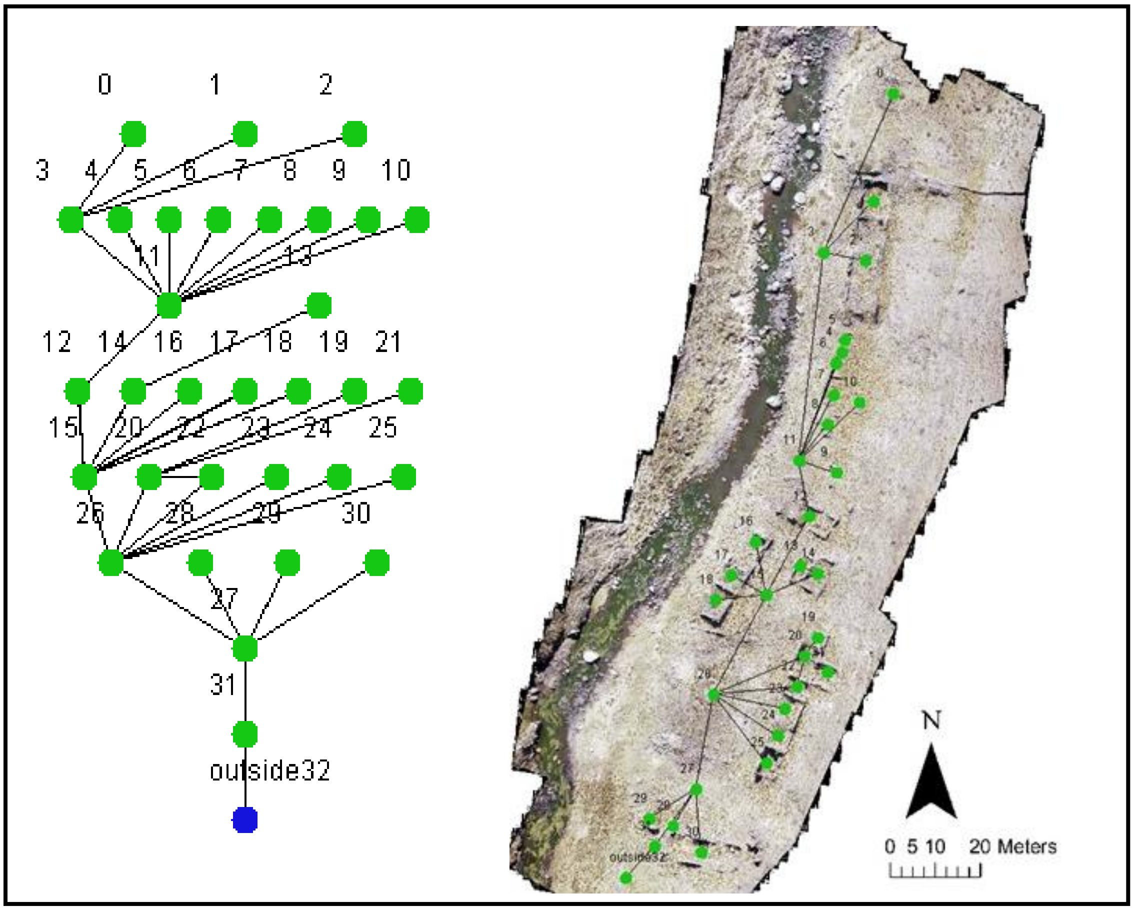

Figure 5.11: (Left) Trapiche's justified permeability graph, and (Right) and the location of nodes and links.

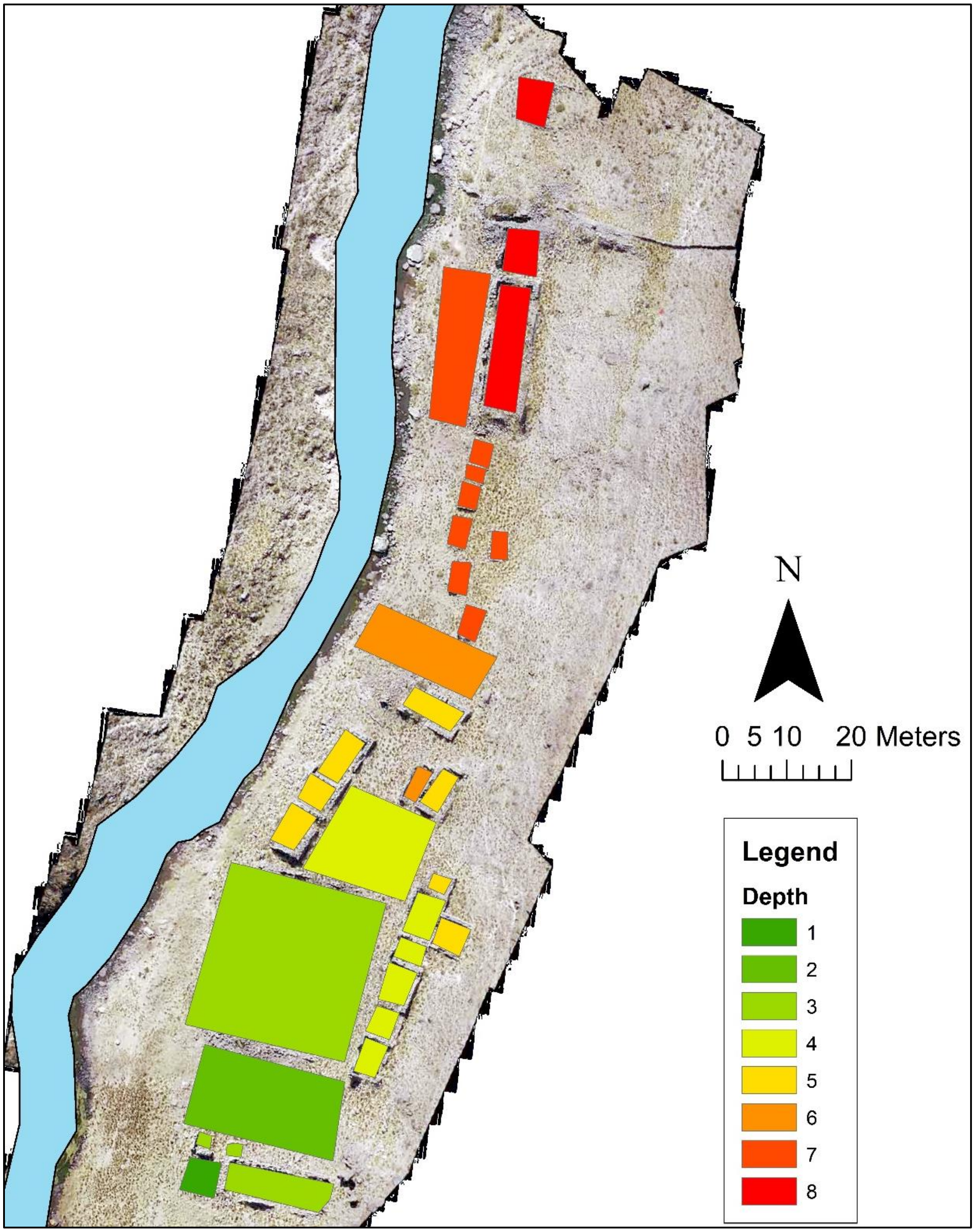

Figure 5.12: Depth at Trapiche.

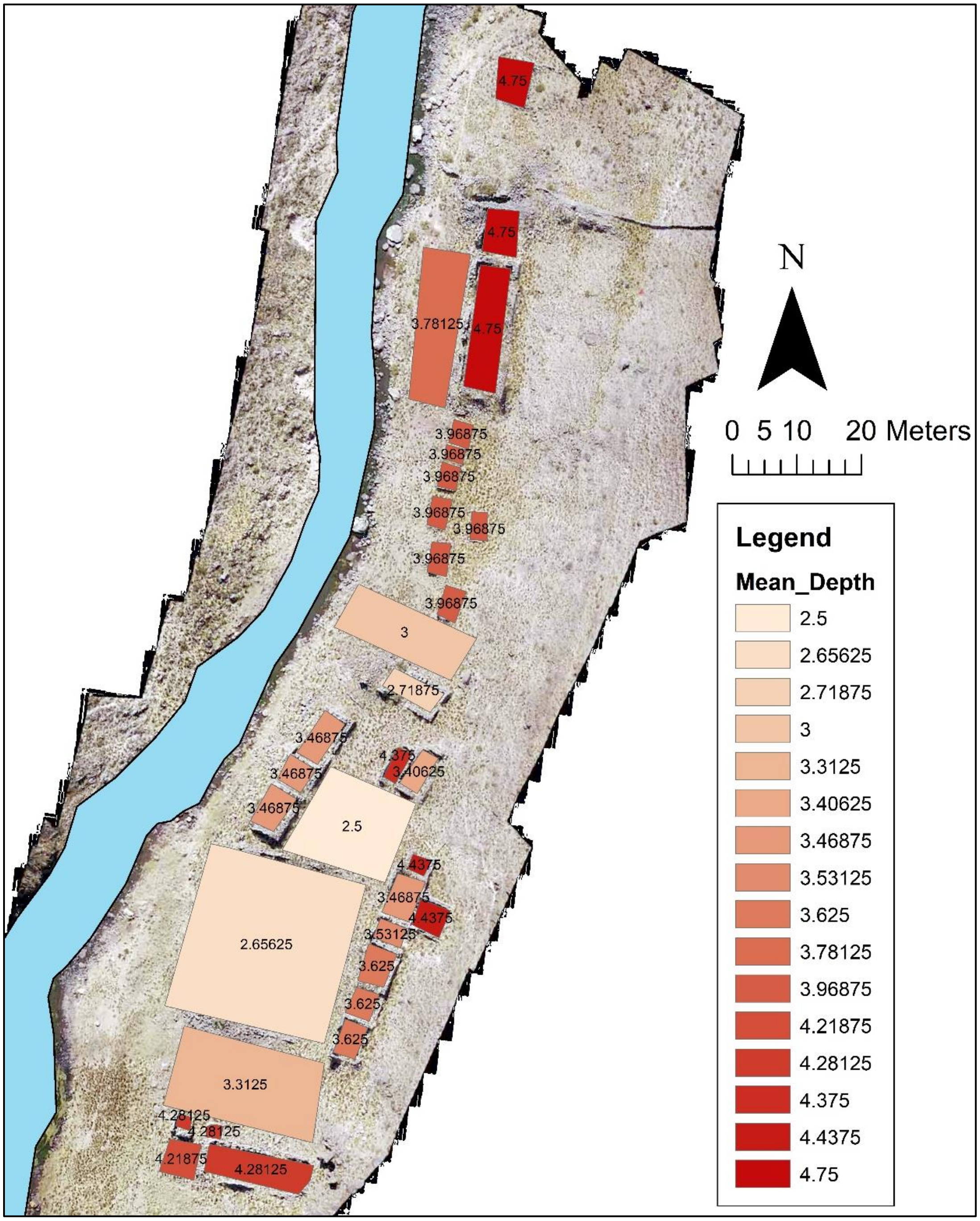

Figure 5.13: Mean depth at Trapiche.

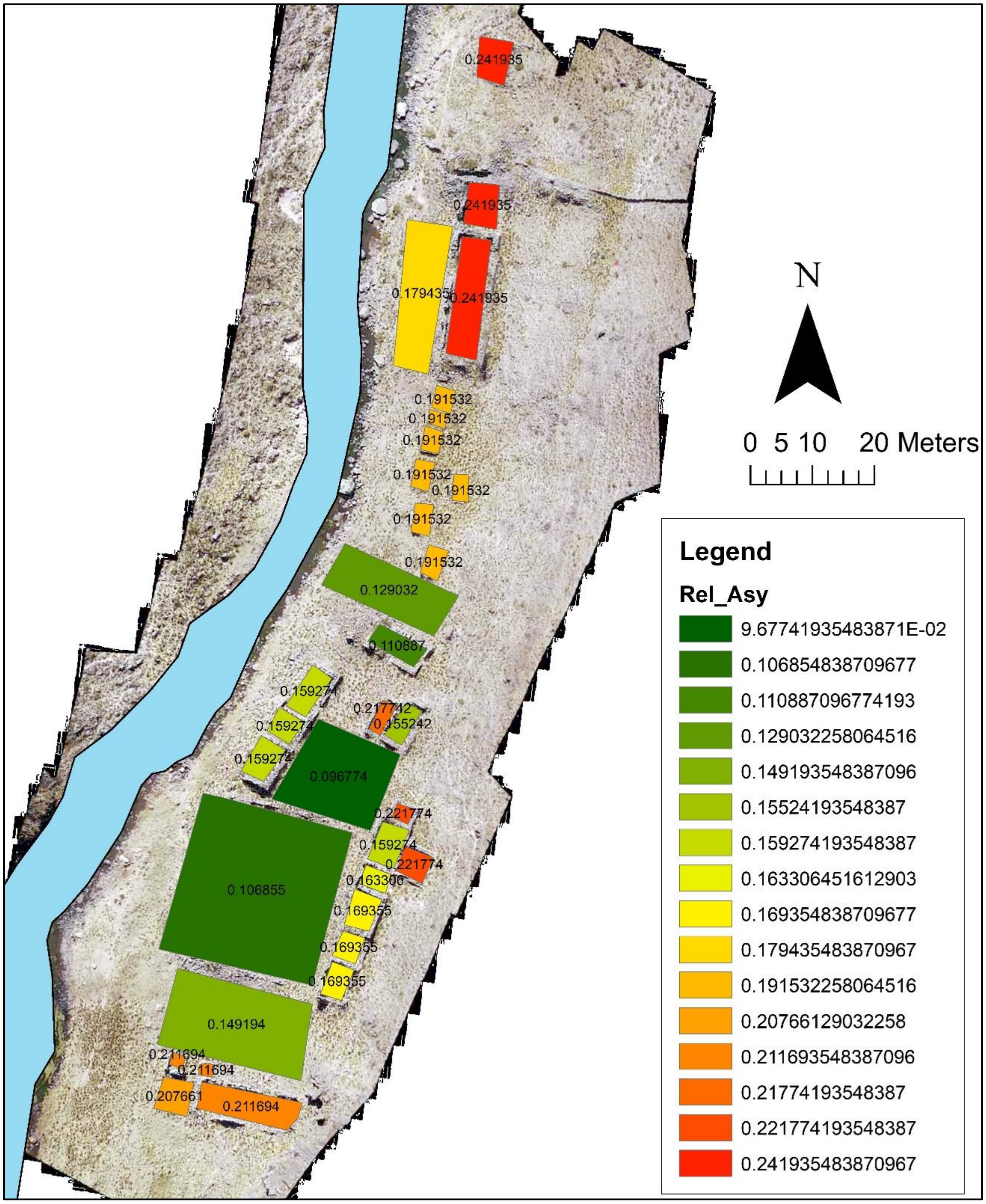

Figure 5.14: Relative asymmetry at Trapiche.

5.6 Interpretation of Results

5.6.1 Space Syntax Comparison

Space syntax analyses at the sites of Chorrillos, Santo Cristo, and Trapiche reveal varying levels of control, restriction, and inaccessibility at colonial period silver refineries in the Puno Bay (Table 5.1). Chorrillos appears to have been much more segregated and controlled than either Santo Cristo or Trapiche. However, because of Trapiche's location wedged between a river and a steep cliff, it had greater depth and lower connectivity values compared to both Chorrillos and Santo Cristo.

At Chorrillos, use of space was not integrated and equal, and some individuals certainly would have had more access to certain spaces than others. If indigenous laborers were living in Chorrillos's western dormitories, they would have had restricted access to the principal entrances of the site. This means that travel in and out of the refinery, such as to meet with muleteers, traders, or members of their families, was likely highly restricted at Chorrillos. In addition to being difficult to enter and leave, the western section of Chorrillos was also one of the easiest areas to control at the site. The western area sits on an inclined hillside and would have been entirely visible from the lower, eastern sector of the site. The entire area is bordered by a 4-5 m (13-15 ft.) tall wall. Travel and foot traffic in and out of this area was controlled primarily by the southern administrative buildings near the chapel. This entrance to the western sector of the site would have been an important control point for overseers and guards.

Space syntax results for Santo Cristo and Trapiche reveal less control and restriction than at Chorrillos. Both Santo Cristo and Trapiche did have clearly segregated areas, such as their grinding mills, amalgamation structures, and administrative structures. However, when looking at the overall integration/segregation of each refinery, Chorrillos was more segregated than either Santo Cristo or Trapiche. Chorrillos had the highest total relative asymmetry value (was the least integrated) with 62.21, while Santo Cristo (37.12) and Trapiche (39.10) had much smaller values. These results indicate activity and control at Chorrillos was different than at Santo Cristo or Trapiche, and Chorrillos likely functioned as a much more regulated refinery.

Table 5.1: Site-Level Space Syntax Results.

Site	Type	Depth	Connectivity (1 link)	Connectivity (2 links)	Mean Relative Asymmetry	Total Relative Asymmetry
Chorrillos	Ingenio?	6	2.1	16.1	0.987	62.21
Santo Cristo	Ingenio and Trapiche	6	1.95	11.1	0.928	37.12
Trapiche	Trapiche	9	1.93	6.43	1.221	39.1

5.6.2 **Ingenio, Trapiche, or Something in Between?**

Following the space syntax analysis, it appears that working and living conditions would have been different within these three Puno Bay refineries. The wide range of control, limited access, and work arrangements at Chorrillos indicate very tight control and exploitative conditions – something similar to how *ingenios* were commonly described in historical documents (see Chapter 2). Because a large amount of capital was needed to build an *ingenio*, with large iron or copper stamp mallets, control at *ingenios* was likely much more intense. This may have been to protect large investments in refinery architecture, or it might reveal there were larger quantities of precious silver and mercury stored at these sites. Interestingly, we found no evidence for water-powered mills or stamp heads at Chorrillos (Chapter 4), although this does not necessarily mean they were not part of the site during its earlier occupational phases. We also uncovered a large amount of Andean *quimbaletes* (hand-powered grinding stones) at Chorrillos, signaling it was used, in part, as a *trapiche* during some periods of occupation and use.

In contrast to Chorrillos, the space syntax results suggest a more fluid and negotiated situation of power and control at the other two refineries: Santo Cristo and Trapiche. This analysis was more complicated at Trapiche than Chorrillos, as the environmental conditions surrounding Trapiche (the river, the steep cliffs, etc.) were not easy to factor into the space syntax architectural analysis. Historical documents record the site of Santo Cristo as having both an *ingenio* and *trapiche*, while the site of Trapiche likely originated as a *trapiche* (see Chapter 4). While this sample size is quite small, these results do indicate that not all *ingenios* were as controlled and exploitative as the historiography depicts. In fact, Santo Cristo was much less controlled than Chorrillos, and Chorrillos (with its inclusion of a larger number of Andean *quimbaletes*) would likely have been categorized as a *trapiche* according to some of the older "type" systems of refinery classification (Bakewell 1984).

Instead of looking primarily at the type of refining infrastructure in each site, the overall size of each refinery may have played a larger role in the observed patterns in the space syntax analysis. Chorrillos was much larger than the two other sites, and with its size it would have likely housed more laborers. It was also the only site to have a high wall surrounding its entire area. Potentially, Chorrillos could have been the Puno Bay refinery that listed as housing over sixty indigenous laborers in the 17th century (Chapter 2, also Galaor et al. 1998:146). With a large number of laborers would come more need for control and order, and this may explain the space syntax results at Chorrillos.

Another hypothesis for our results would be that proximity to colonial urban centers affected control and exploitative working conditions at these refineries. Chorrillos, the most controlled and segregated refinery of the three, is located only within a few kilometers of the colonial mining *asiento* of San Luis de Alba de Laicacota, as well as only within 5 km of the town of Puno. In comparison, Santo Cristo and Trapiche are each located over 12 km from San Luis de Alba and Puno. While all three refineries were located near colonial roads and would have been accessible from urban centers during a day's walk (see Chapter 9), Santo Cristo and Trapiche may have been rural and removed enough to avoid some of the most exploitative working and living conditions in colonial society at that time. Perhaps their distance from urban colonial society allowed for a wider range of flexible working arrangements.

A final hypothesis considers the environmental and physical location of the refineries. Santo Cristo and Trapiche are both located in river valleys, while Chorrillos is located on a flat plain. The geography of the Santo Cristo and Trapiche refineries may have necessitated a layout with less built-in controls and segregated areas than what was observed at Chorrillos. In the case of Trapiche, its location in a steep river valley, with cliffs and a river on either side, may have acted like a natural walled enclosure. So, while the space syntax analysis looked at control, access, and segregation within building architecture at these refineries, it was not able to analyze the surrounding geographical landscape for similar, "natural" enclosures and observation points. Trapiche, in fact, could be considered a location where overseers and owners had greater sightlines to monitor activity in the main work patio from their houses on the cliffs above the site.

5.7 Summary

This chapter used space syntax analysis to examine the spatial layout of three Puno Bay refineries: Chorrillos Itapalluni (“Chorrillos”), Santo Cristo, and Trapiche Itapalluni (“Trapiche”). Our results indicate the presence of restricted and segregated areas at all three refineries. However, a comparison between the three refineries highlighted the especially segregated and controlled nature of Chorrillos, in contrast to the more open and less restricted layout of both Trapiche and Santo Cristo.

The results do not follow the traditional “type” classification for silver refineries at Potosí and the colonial Andes (either *ingenio* or *trapiche*). Instead, the three refineries appear to have a mix of controlled and accessible areas, which were likely more dependent on their environmental location, as well as their proximity to larger colonial cities.

6.0 Identifying Metallurgical Activity with pXRF

6.1 Introduction

Following the space syntax analysis at Chorrillos, Santo Cristo, and Trapiche, we chose Trapiche for further archaeological analyses due to its more removed location from colonial cities of the time period. Prior to our excavations at Trapiche, a geochemical soil survey was conducted at the site to identify potentially unsafe and hazardous excavation areas due to the historic practice of silver refining. Dr. Sarah Kelloway from the University of Sydney joined the team to conduct a soil survey using field portable X-ray fluorescence spectroscopy (pXRF). Portions of this chapter and pXRF analysis have already been published (Kennedy and Kelloway 2019, 2020a, 2020b, and *in press*).

PXRF has been increasingly used to test potentially toxic levels of heavy metals in modern mining and industrial waste sites. Understanding the concentration and spatial variation of pollutants in soils is necessary for identifying proper prevention measures for soil contamination and long-term effects on human health. Although pXRF studies have been highly effective and widely utilized in modern public health, pXRF analysis has seen relatively little utilization in health and safety measures for excavations of industrial archaeological sites, such as Trapiche.

Archaeological hazardous heavy metal soil testing protocols varied for excavations in Peru. Many of the safety regulations and best practices outlined by the U.S. Environment Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA) are not required for private projects. Soil testing methods available to local archaeologists were expensive and time-intensive, due to out-of-country testing or specialized equipment. pXRF analysis was able to fill our need for rapid, onsite soil testing.

PXRF has also been shown to provide real-time data processing in the field, which can inform day-to-day objectives and excavation decisions. Further, pXRF studies have been shown to be especially valuable where a given activity is associated with a specific element, essentially providing a diagnostic elemental marker in the soil (Millard 1999; Jones 2001; MacKenzie and Pulford 2002; White and Dungworth 2007). Because of these reasons, we decided to conduct a pXRF soil survey at Trapiche prior to excavations.

6.1.1 XRF and pXRF Analysis

X-ray fluorescence (XRF) is based on the differential absorption rate of high-energy X-rays by different elements. In either energy-dispersive (ED) or wavelength-dispersive (WD) spectroscopy, X-rays are used to excite electrons within elements of a sample (in our case, surface soil samples). When the electrons return to their normal, non-excited state, they emit photons while fluorescing the X-rays. Every element emits a different number of photons during this fluorescing process, allowing researchers to determine levels of elements present in soil samples (Malainey 2011:26). In a laboratory setting, samples are sieved and crushed to remove all contaminates and to produce a homogenous sample with even particle size prior to analysis. Laboratory XRF also takes place under a vacuum to limit the loss of light elements during analysis (Malainey 2011).

The introduction of portable or hand-held X-ray fluorescence (pXRF) technology has had a significant impact on soil science, public health, and archaeology over the past few decades. The technology was originally developed for mineral and mining research and was not developed to be as precise as laboratory XRF devices. However, its aim was still to determine different levels of elements within a sample. The many positive aspects of pXRF (its portability, its non-destructive nature, its low cost, and its commercial availability) have made it a powerful tool for a variety of researchers. The technology works much the same as XRF, although again, the measurements are often less precise. Because most pXRF instruments do not come equipped with a vacuum, they do have a more limited range of elements possible for detection, and lighter elements are almost always outside the range of the instrument (Malainey 2011).

6.1.2 **Common Issues with pXRF and Soils**

Methodological issues related to pXRF technology within the field of archaeology have been widely detailed over the last decade (Aimers el al. 2013; Hunt and Speakman 2015; Killick 2015; Shackley 2010, 2011; Speakman et al. 2011; Speakman and Shackley 2013). Many archaeological studies have used pXRF analysis to chemically characterize obsidian, metal, and ceramics. As our present study focuses on the identification of heavy metals in soils, I will only summarize issues related to soil-based pXRF studies.

A major issue affecting pXRF analysis of soils in the field is the environment. Altitude, soil moisture, and soil matrix all affect pXRF readings. High altitude has been shown to affect pXRF instruments, resulting in higher concentration readings of certain elements at higher altitudes, or total malfunction of the instrument itself, due to internal condensation and unequal air pressure within the X-ray tube (Merill et al. 2018). These effects are particularly important when considering work in the Andes. Soil moisture can also affect pXRF readings, with moisture changes occurring over the course of a day, as well as over multiple days. Further, *in situ*, un-prepped soil samples will not be homogenous, which can lead to high sample variability.

6.1.3 **Best Practices for Industrial Soil Testing**

When assessing Trapiche for hazardous metals, we followed best practices and guidelines set by the U.S. Environmental Protection Agency (EPA). In modern contexts, sites with contamination are evaluated by how often the area is frequented, and if there is adequate ground cover on the soil, which diminishes the amount of contaminated dust in the air.

The standard practice of reporting heavy metal levels for the EPA varies, but most often it is in milligrams (mg) or micrograms (μg) of the hazardous element per mass of soil (kg). The conversion from ppm to mg/kg in soil is 1 ppm = 1 mg/kg, which also equals 1,000 μg/km. To convert ppm to micrograms per volume of air ($\mu g/m^3$), we used the EPA's conversion formula based on molecular weight of each element. Atmospheric temperature and air pressure affect this calculation, and we used typical conversation standards of a pressure of 1 atmosphere and 25°C (77°F). To convert 1ppm to its air concentration, the equation is: 0.0409 x 1 ppm x molecular weight.

6.2 Puno Bay Refining Signatures

Our pXRF study focused on the site of Trapiche, located south of the Puno Bay. As already summarized in Chapters 2-3, the Puno Bay was a key location for indigenous and colonial silver production., and the discovery of the Laicacota silver mine in 1657 initiated a huge boom in silver production. Silver ore was processed at silver refineries using mercury amalgamation, known as the patio process technique. Lead, copper, mercury, antimony, and iron are the most common heavy metals directly related to this process. Because colonial silver refining used specific heavy metals during specific stages of the process, (Table 6.1) pXRF can identify concentration areas of metals that link back to stages of refining. The locations of architectural elements such as grinding stones, ovens, and water tanks can be combined with soil pXRF analysis to further identify metallurgical areas.

Table 6.1: Stages of the Patio Process.

Stage	Description	Components	Associated Heavy Metals	Associated Architecture
1	Grinding ore	Silver sulfide ore	Ag, S, Fe, Pb, Sb	Grinding mill
2	Screening ore	Ground ore	Ag, S, Fe, Pb, Sb	Screens
3	Roasting ore	Ground ore + salt	Ag, S, Fe, Pb, Sb, NaCl	Reverberatory furnace
4	Mixing ore	Ground ore + salt + *magistral* + mercury	Ag, S, Fe, Pb, Sb, NaCl, Cu, Hg	Patios, containers
5	Amalgamating ore	Mercury/silver amalgam	Ag, S, Fe, Pb, Sb, NaCl, Cu, Hg	Patios, containers
6	Heating amalgam	Mercury/silver amalgam	Ag, S, Fe, Pb, Sb, NaCl, Cu, Hg	Patios, containers
7	Washing amalgam	Mercury/silver amalgam + water	Ag, Hg	Tanks, cisterns, canals
8	Squeezing amalgam	Mercury/silver amalgam	Ag, Hg	Cheese cloth
9	Reheating	Pure silver + vaporized mercury	Ag, Hg	Molds, ovens

6.3 Methodology

6.3.1 **Survey Methods**

We established a survey grid across the site of Trapiche, with *in situ* soil pXRF analysis occurring at 5 m intervals (Figure 6.1). The survey was concentrated within the architectural core of Trapiche, in Sectors A, B, and C. The analyses were taken from within buildings, patios, and middens and each sampling location was recorded using a total station. Prior to analysis with the pXRF, each survey point was cleared of 3-5 cm of surface debris and photographed. Sample areas were approximately 10 cm x 10 cm in size. Roots and pebbles were avoided for analysis, with the scrapped earth visually checked and tapped back down before analysis. A polypropylene film was placed over the sample area before placing the window of the pXRF on the analysis spot to ensure the pXRF window was kept clean. The film was cleaned with a microfiber cloth between each sample location (Figure 6.2).

In total, 100 sample spots were analyzed at Trapiche, with three additional control locations taken outside of the site boundary, for a total of 103 readings. The pXRF survey took three days, for an average of 34 samples per day. Each night, the data was downloaded from the pXRF instrument and stored electronically. Output was in parts per million (ppm). The results of the pXRF survey were available immediately and were used to make real-time decisions about subsequent archaeological excavation at Trapiche.

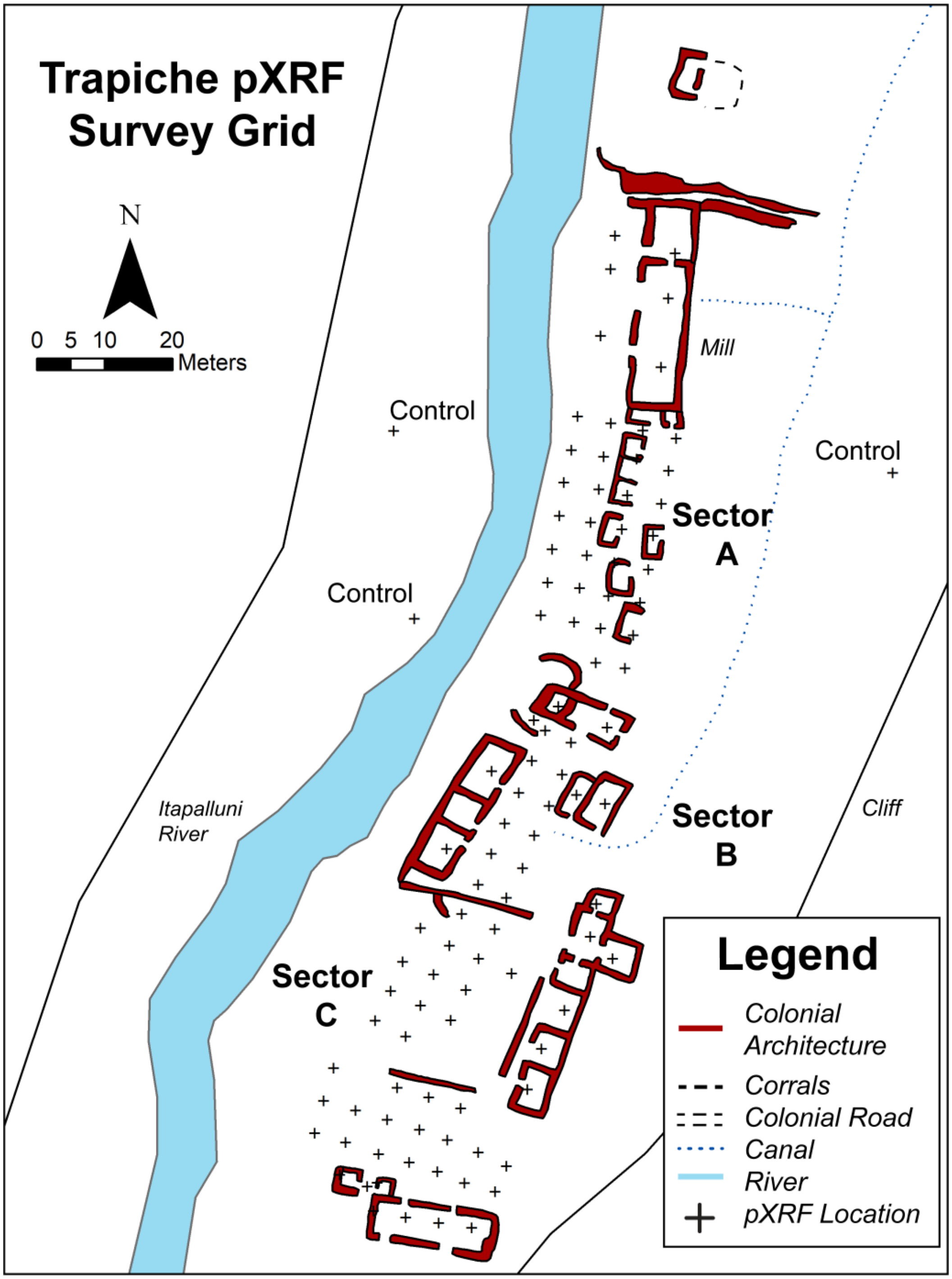

Figure 6.1: pXRF survey grid in 5m intervals across the architectural core of Trapiche.

Figure 6.2: (Left) The pXRF instrument was pressed to the soil to take readings, and (Right) photographs were taken of each pXRF sample location.

6.3.2 **PXRF Setup**

The field survey was conducted using an Olympus Delta Premium (model DP-6000-C) portable XRF spectrometer, equipped with a Rh-anode tube and borrowed from the Mark Wainwright Analytical Centre (MWAC), University of New South Wales. The factory-set Soil Mode was selected as the initial basis for the work program covering the following elements: P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, As, Se, Rb, Sr, Y, Zr, Nb, Mo, Ag, Cd, Sn, Sb, W, Hg, Pb, Bi, Th and U. Soil Mode operates three beams at various voltage, current, and filter settings, using a Compton normalization method for calibration: beam 1 at 40 kV, 72 µA (150 µm Cu filter); beam 2 at 40kV, 73 µA (2mm Al filter); and beam 3 at 15 kV, 132 µA (100 µm Al filter). Each mode was run for 30 seconds live time and the total area of the spot analyzed by the instrument was approximately 8 mm x 10 mm. A standard was also run throughout the day to check for changes that might affect readings.

6.3.3 Factor Correction

Results from the field indicated that certain element values were probably beyond the factory Soil Mode calibration range. As such, representative survey points were sampled and the soils sent to the XRF Laboratory, MWAC, for analysis and use as standards for factor correction of the Soil Mode program. These soil samples were passed through a 500 µm sieve and split into quarters using a riffle splitter. A quarter of each sample was ground in a tungsten carbide mill for 90 seconds, with the remainder kept aside for other analyses. Subsamples of the ground material were analyzed by laboratory-based XRF using a PANalytical Axios Advanced WD-XRF spectrometer, equipped with a Rh tube. Pellets were made for trace element analysis by the Protrace program and in the case of Hg, a selection of samples representative of the concentration range covered were submitted for ICP-MS analysis. Glass beads were made for major element analysis, which were measured using a WROXI-based program. These results formed the expected standard concentrations for factor-correction. Another subsample of ground soil was analyzed on the pXRF spectrometer in cups using polypropylene film, and these values then formed the observed values to be used in correction.

To determine if factor corrections were indeed needed, the observed values to be used in correction were plotted against the WD-XRF laboratory results/expected results. A review of each element was performed, and the relative errors were calculated for the samples (Table 6.2). Some elements were immediately excluded from analysis: Co and W were potential contaminants from grinding the subsamples; Ti, V, Zn, Rb, Sr, Y, Zr, Nb and Th were not considered significant to the patio process and were excluded; Cl, as no values were determined by WD-XRF and so correction could not take place; Ni, Se, Mo, Cd, Sn, Bi and U were excluded as pXRF and WD-XRF results were typically below levels of detection and not enough samples had values above levels of detection to make a plot for correction, and where observed concentrations were above detection, relative errors were too high to consider using the values without factor correction. High relative errors and levels of detection also meant the exclusion of P and Cr.

Other elements did not require correction (K, Ca, and Cu) and some elements only needed corrections where concentrations were above a threshold determined by inspecting plots and relative errors (Fe levels over 10,000 ppm; Pb levels over 1,000 ppm; Hg values over 100 ppm). For S, separate factor corrections were needed for samples with high Fe, S, and Pb.

Table 6.2: Elements Excluded Following Recalibration.

Element Name	Symbol	Atomic Number	Reason for Exclusion
Chlorine	Cl	17	No expected values were determined
Titanium	Ti	22	Not of interest for patio process
Vanadium	V	23	Not of interest for patio process
Cobalt	Co	27	Excluded because tungsten carbide mill contamination
Nickel	Ni	28	Concentrations were below detection
Zinc	Zn	30	Not of interest for patio process
Selenium	Se	34	Concentrations were below detection
Rubidium	Rb	37	Not of interest for patio process
Strontium	Sr	38	Not of interest for patio process
Yttrium	Y	39	Not of interest for patio process
Zirconium	Zr	40	Not of interest for patio process
Niobium	Nb	41	Not of interest for patio process
Molybdenum	Mo	42	Concentrations were below detection
Cadmium	Cd	48	Concentrations were below detection
Tin	Sn	50	Concentrations were below detection
Tungsten	W	74	Excluded because tungsten carbide mill contamination
Bismuth	Bi	83	Concentrations were below detection
Thorium	Th	90	Not of interest for patio process
Uranium	U	92	Concentrations were below detection

Where a correction was required, a factor was then applied to Soil Mode based on the linear equation resulting from the plot of the observed pXRF and WD-XRF values of the subsampled soils. The accuracy and precision of the corrected pXRF subsoil data was determined by comparing said data with the corresponding WD-XRF concentrations for samples that had been excluded from factor correction work. Checks suggest that one could consider the level of determination for Ag and Sb to be ~20 ppm. Once the accuracy and precision were deemed suitable, all the original pXRF data collected in the field were recalculated. As a result of this whole process, the following elements were used in data analysis: S, K, Ca, Mn, Fe, Cu, As, Ag, Sb, Hg and Pb (Table 6.3).

Table 6.3: Factor Corrected Elements.

Element Name	Symbol	Atomic Number	Observations/Comments	Conclusion
Phosphorus	P	15	High scatter and poor relative error	Not used
Sulfur	S	16	Separate factor correction needed due to high values; readings appear to have been affected by high altitude	Included
Potassium	K	19		Included
Calcium	Ca	20		Included
Chromium	Cr	24	High scatter and poor relative error	Not used
Manganese	Mn	25		Included
Iron	Fe	26	Separate factor correction needed for levels over 10,000 ppm	Included
Copper	Cu	29		Included
Arsenic	As	33		Included
Silver	Ag	47		Included
Antimony	Sb	51		Included
Mercury	Hg	80	Separate factor correction needed for levels over 100 ppm	Included
Lead	Pb	82	Separate factor correction needed for levels over 1,000 ppm	Included

Although our pXRF results were compared to laboratory WD-XRF results and factor corrections were carried out to ensure the necessary concentration range for each element was covered, and checks were made to evaluate accuracy and precision, it is important to note that a variety of other effects still played a role in our analysis in the field. For example, moisture, homogeneity, particle size, mineralogy, and compactness can affect *in situ* pXRF analysis of unprepared soil samples. Therefore, the discussion of the pXRF survey data is best considered to be semi-quantitative only, and we combine the results of the geochemical survey with data from the surface artifact collection to arrive at my interpretations. Further, P values appear to have been affected by analysis at high altitude, with higher values achieved at high altitude (Puno) compared with low altitude readings (Lima, Peru and Sydney, Australia).

6.3.4 **Data Analysis and Interpretation**

The corrected pXRF results are located in Appendix B. Following factor correction, pXRF values were imported into ArcGIS and spatially mapped with ArcMap to visualize relationships. All values were viewed in ppm. We used proportional symbols and colors to represent variation and relied on ArcMap's natural breaks (jenks) classification method to characterize the data, although in some cases we manually adjusted categories. To identify areas of intense metallurgical activity, we converted each element's 103 points to a raster with cell size 4, then reclassified on a scale of 0-4. We assigned 0 for no data, 1 for lowest ppm values, and 4 for highest ppm values. The classes were based on natural breaks. The raster values for each element were added together to produce a cumulative raster, which was resampled (bilinear) to achieve smoother lines for easier visualization.

Statistical analyses on pXRF data were carried out with SYSTAT software. Hierarchical cluster analysis was conducted on non-standardized ppm values using complete linkage (farthest neighbor), using the Pearson correlation coefficient (Pearson's r) with a distance metric of 1. It is common to use complete linkage on measurements of chemical elements within samples that have similar baseline composition. Principal component analysis was also conducted on non-standardized ppm values.

6.3.5 **Control Samples**

Three control samples were taken outside of the site boundary to determine a natural soil level baseline for the area (Appendix B). Natural soils from the controls included relatively high levels of K, Ca, Mn, and Fe, consistent with normal soil values in this area of the Andes. Sulfur (72 ppm), copper (62.3 ppm), arsenic (36.8 ppm), mercury (8.2 ppm), and lead (163.3) averages for the three controls indicate their relatively low levels in natural soils. Chlorine and antimony were below levels of determination in the control samples. Further, of these control samples, Control 3 was taken from the same side of the Itapalluni River as the site, at a higher elevation than the site itself, and has generally lower values of S, Cu, As, Ag, and Hg. The other two controls were taken from the western side of the riverbank and have relatively higher values of the aforementioned elements, possibly due to wind-blown contaminants from the nearby mill.

6.4 Effects on Human Health

pXRF results revealed hazardous levels of seven heavy metals in Trapiche soils: manganese (Mn), copper (Cu), arsenic (As), silver (Ag), antimony (Sb), mercury (Hg), and lead (Pb). Average element concentrations in soil and air dust at Trapiche exceeded both the EPA and OSHA safety standards for arsenic, antimony, mercury, and lead. The highest concentrations clustered around the grinding mill, as well as the central and southern patios (Figure 6.3).

Danger to human health during archaeological excavation was assessed for daylong exposure of dust from soil, estimating an 8-hour workday, 40-hour work week, and two-month excavation season, for 320 hours of potential exposure/person. We used the EPA's regional screening level (RSL) calculator intended for Superfund sites. In our calculations, we used estimations for "sub-chronic" toxicity and "outdoor worker," because worker exposure was limited to a two-month period. This estimated a reasonable maximum of soil intake, and we altered exposure parameters relevant to our study location (dry climate zone, high vegetative cover). Due to multiple elemental contaminants at the site, we chose a target hazard quotient of 0.1, and a target risk of 1E-05 based on the EPA's outdoor worker sub-chronic toxicity standards. The results of our calculations are presented Appendix B and reveal notable health risks to workers at Trapiche from a 2-month exposure to lead and mercury.

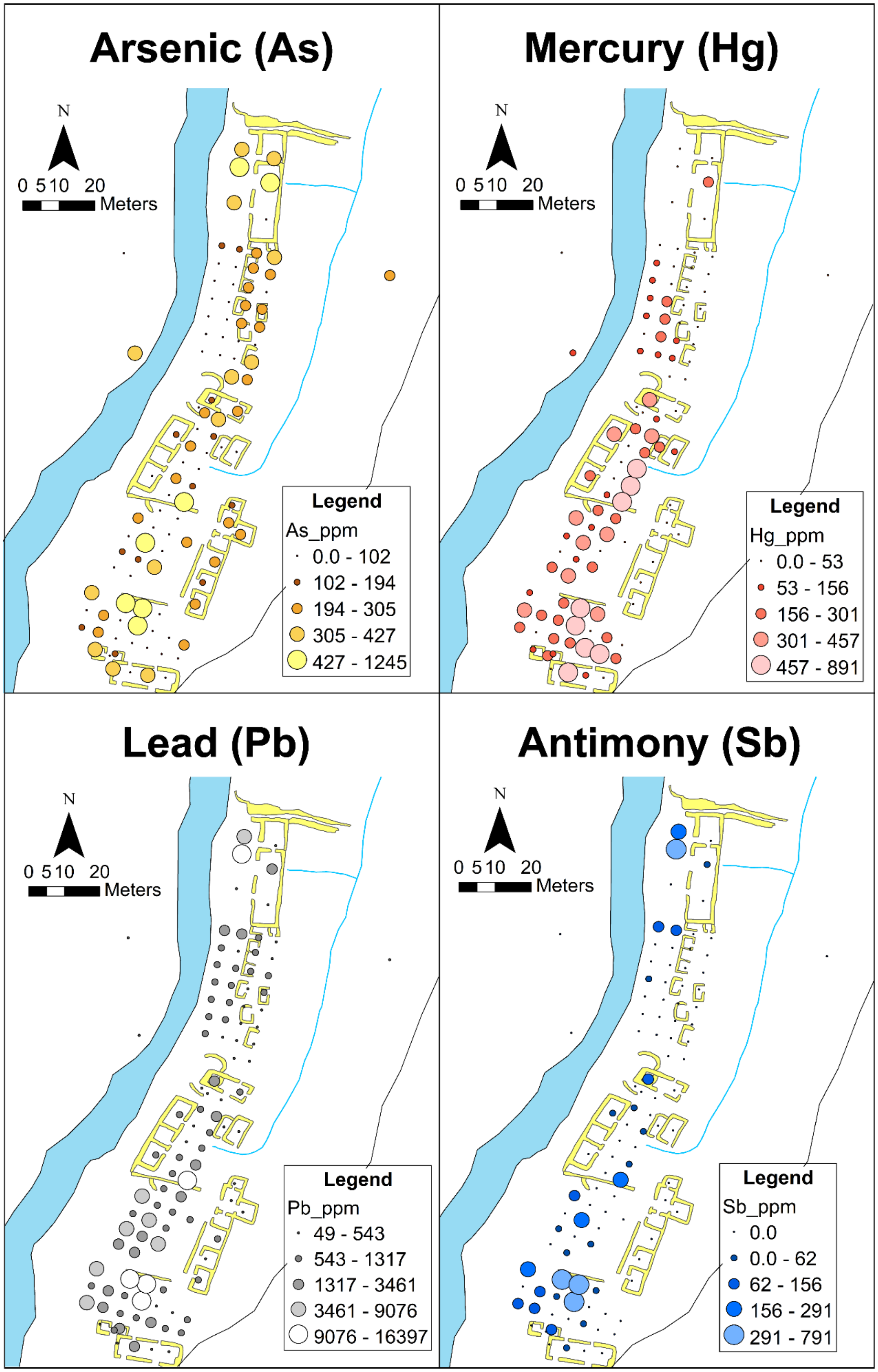

Figure 6.3: Four maps depicting high levels of As, Hg, Pb, and Sb in surface soils at Trapiche. Large circles and lighter colors indicate the highest level of contamination.

Following our health and safety evaluations, we decided to relocate seven excavation units from areas with the highest concentration of heavy metals. Further, we chose not to excavate anywhere near the grinding mill, reverberatory furnace, or southern patio. To mitigate inhalation of contaminated dust particles from the remaining excavation units, project workers were required to use personal protective equipment (PPE), which mitigated health risk in our evaluations. PPE included protective glasses, 3M respirator masks, gloves, boots, and overalls (Figure 6.4). Boots were cleaned before leaving the site every day, and overalls and boots were removed before entering homes. Masks were replaced if dust was visible on the inside. Hands and faces were washed before eating, as well as prior to leaving the site each day. Equipment was cleaned and washed following the end of the field season.

Figure 6.4: Project archaeologists wear PPE during excavations, including 3M respirator masks, gloves, hats, boots, long pants and shirts, and coveralls. Photos by Kennedy.

6.5 The Patio Process at Trapiche

Because prehispanic silver smelting technology did not use mercury, we were able to quickly confirm the use of the patio process at Trapiche as high levels of mercury were recorded in over 50% of the pXRF samples. We also identified a European reverberatory furnace located south of the mill. Although we were unable to factor correct for chlorine (Cl), an examination of uncorrected Cl concentrations reveals high levels (>1,000 ppm) near the mill and main patio, as well as the reverberatory furnace (369 ppm). These results indicate salt (NaCl) was added during the early roasting stages *and* later amalgamation stages.

Relatively high readings of iron (>110,000 ppm) and copper (>3,000 ppm) were recorded in Sector B's main patio, indicating their probable use for the reduction of silver chloride to elemental silver, an Andean technique. The distribution of antimony (Sb) at Trapiche was also informative, as antimony only occurs naturally in combination with sulfur, copper, silver, and lead (Anderson 2012). Antimony was present in only 28% of Trapiche samples and was not recorded in any control samples. Antimony *was* identified in the reverberatory furnace (86 ppm), the metallurgical oven (100 ppm), the main patio (>200 ppm), near the mill (635 ppm), and in Sector C (500-800 ppm) (Figure 6.5). Our results indicate that occurrences of antimony at Trapiche are related to processes that separated it from its combined state in ore through grinding or heat.

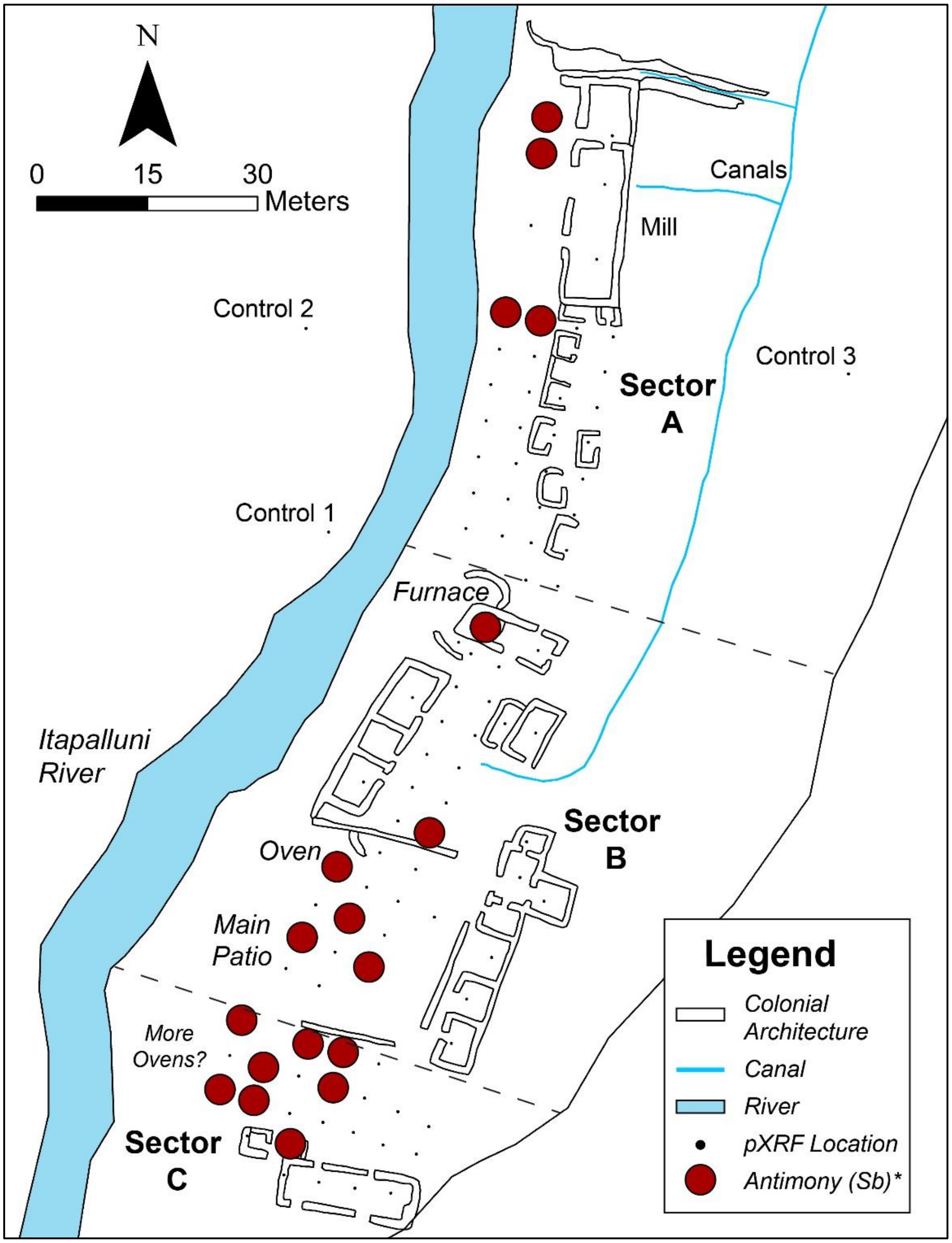

Figure 6.5: Distribution of antimony levels at Trapiche. Sb readings are > 50 ppm.

6.6 Spatial Distribution of Elements

To spatially visualize zones of intense metallurgical activity, we created a cumulative raster from pXRF values (Figure 6.6). Three high-intensity metallurgical areas were identified. These corresponded to the mill, the main patio, and Sector C. Locations with little or no metallurgical activity corresponded to domestic structures.

The highest levels of mercury (>500 ppm) were recorded near the metallurgical oven in Sector B. This confirms the evaporation and collection of mercury in this area. High levels of mercury were also found in structures directly northeast of the mercury oven, indicating they were also used for either mercury amalgamation or the heating and recapture of mercury.

The main patio in Sector B was another area of intense metallurgical activity and was the likely location where various agents, such as copper sulfate and iron, were mixed with silver ore in heated vats (*buitrones*). The highest readings of S (14,565 ppm), Sb (791 ppm), Fe (120,631 ppm), and Cu (3,822 ppm) occurred directly south and downhill of the main patio. We interpret these high values in Sector C as the result of erosion and runoff from the principal work patio. However, we cannot eliminate the possibility that Sector C was used for amalgamation processes.

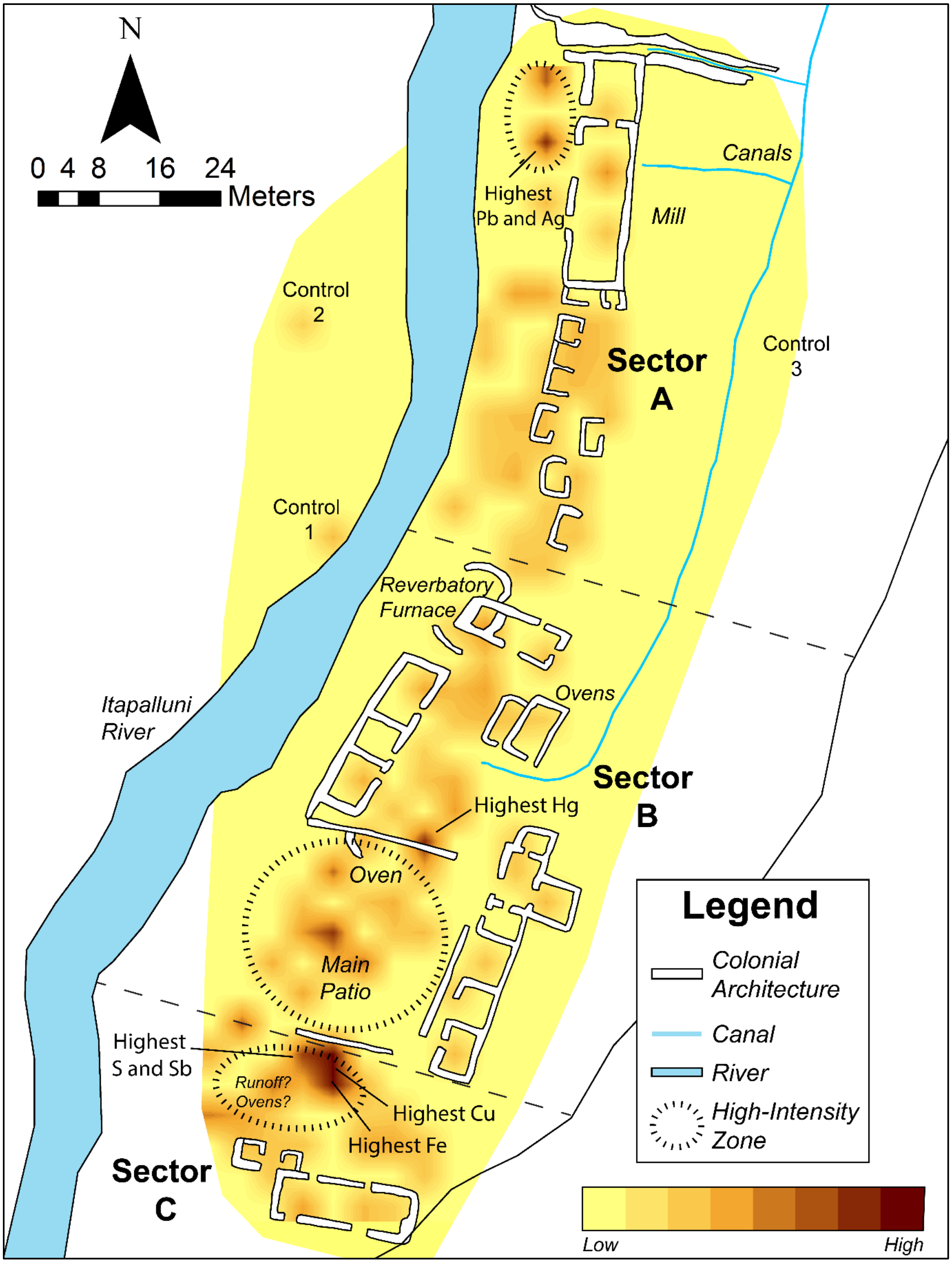

Figure 6.6: Trapiche cumulative raster depicting zones of intense metallurgical activity.

Hierarchical cluster analysis (Appendix B) with complete linkage was used to compare and group similar elemental values and is represented in a dendrogram (Figure 6.7). The most-similar elements clustered first, on the far-left of the graph. Sulfur and antimony grouped together for the first linkage, indicative of their closely combined state in nature (Anderson 2012). They also group with silver in the first cluster, likely representative of silver sulfide ore, such as argentite (Ag_2S), mined in the Puno Bay (Schultze 2008). Arsenic, copper, and lead also form an early cluster. This may indicate use of a lead ore combined with copper, silver, and antimony, possibly in pyrite, sphalerite, or barite. However, lead galena (PbS) has also been identified as a common Puno Bay lead source (Schultze 2008). Perhaps the arsenic, copper, and lead cluster indicate the composition of copper ore brought to Trapiche for use in the *magistral*.

Mercury and iron also join the arsenic, copper, and lead cluster, although many linkages later. In fact, mercury is one of the very last elements to join a cluster during the hierarchical cluster analysis. This highlights mercury's unique use and importance as it was added to the ore mixture at multiple stages of the patio process. It also highlights how ubiquitous mercury was at the site (in 75% of all samples). Calcium and potassium form the final cluster of the analysis and represent natural elements present in soils throughout the site.

Principal component analysis was conducted to evaluate potential groupings of survey locations by elemental concentrations across the site (Appendix B). The first three components accounted for over 90% of the variation in the sample population. Many samples taken from Sector A, as well as some from Sector B, appear to form a group. They are distinguished from the remainder of the locations due to higher K and Ca values and relatively lower amounts of Hg, Pb, As, Cu, S, Ag, and Sb. These results are consistent with areas of the site not being used for intensive metallurgical activities in comparison with the remainder of Trapiche. This group includes locations outside of the mill area in Sector A, apart from one mill building sample, buildings in both Sectors A and B, and some patio areas of Sector B. In some cases, this association might be due to failing to reach the 'natural ground' due to rubble, particularly in some areas of Sector B where higher amounts of mercury might be expected.

Other locations at Trapiche had relatively high amounts of Pb, As, Cu, S, Ag, and Sb, correlating with grinding activities, and to a lesser extent run-off from canals. Group associations with relatively higher amounts of mercury were found in the main patio, the reverberatory furnace, and Sector C. The high values of mercury in Sector C correlate with the small patio, noted earlier as related to run-off from the main patio, and a small structure which may have been used as storage for silver and mercury. Descriptions of refining mills from this period indicate guarded warehouses of mercury near the principal entrance. The lack of Sector A group associations with mercury suggests that mercury was likely imported to Trapiche in its final form to be added in the amalgamation stages and was not involved in earlier stages of ore processing.

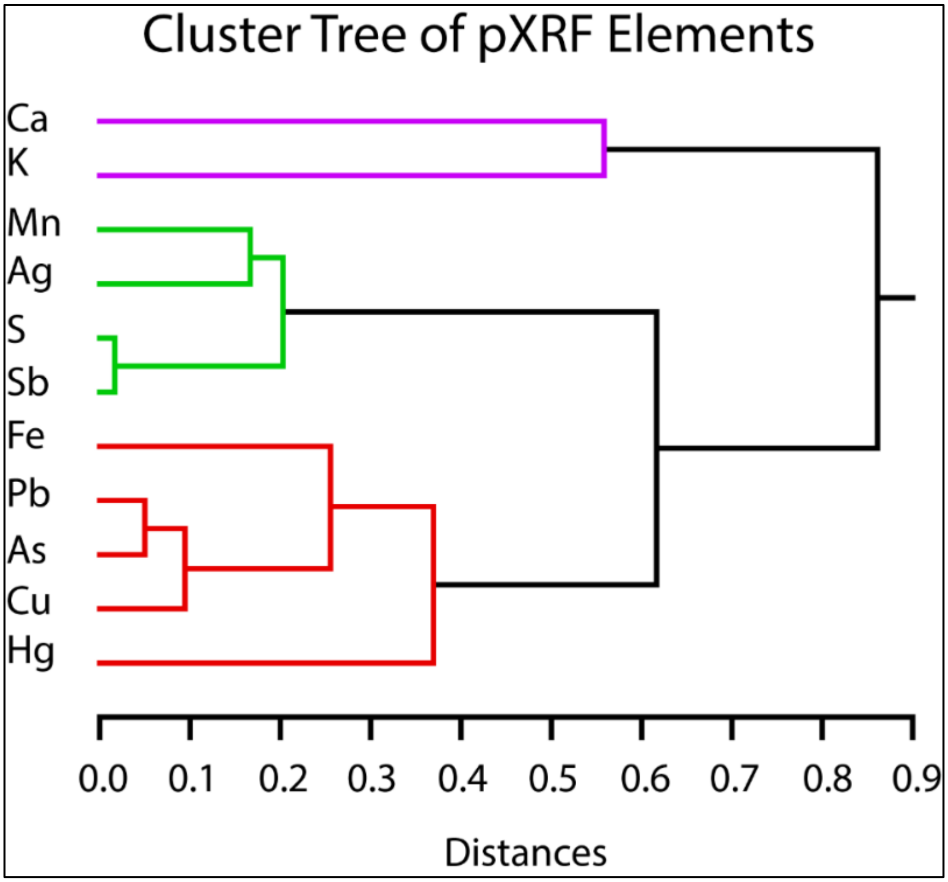

Figure 6.7: Dendrogram representing complete linkage clustering of elements at Trapiche.

6.7 Summary

The pXRF soil survey identified the presence of high levels of heavy metals in the archaeological soils of at Trapiche. Using a pXRF spectrometer, we conducted a site-level soil survey and identified hazardous levels of manganese (Mn), copper (Cu), arsenic (As), silver (Ag), antimony (Sb), mercury (Hg), and lead (Pb) at Trapiche. Some high readings of heavy metals occurred within soils of planned excavation units, necessitating their relocation. pXRF results also confirmed the use of the patio process silver refining technique at Trapiche, as well as multiple Andean adaptations to the said process.

In addition to the confirmation of the patio process, the pXRF analysis revealed the heavily industrial nature of spaces at Trapiche. Every sector had some level of heavy-metal soil contamination, including domestic areas. While there were obviously more industrial (the mill) areas in comparison to more domestic areas (Sector B houses), these findings highlight the overall industrial nature of the site, and the lack of separation of industrial activities from domestic zones. However, it is possible that some temporary domestic structures were located outside of the main architectural core of Trapiche, and these structures would have had little to no contamination.

Within the Trapiche refinery, it is possible to see degrees of toxicity for people living at the site. Sector A housed the mill *and* presumably the dormitories for the indigenous laborers at the site. These structures were located directly south of the mill and would have been susceptible to high levels of toxic dust and silica particles in the air. The water in the river near the mill would have been contaminated as well. In contrast, the structures in Sector B, including the possible owner/overseer's house, were located much further south of the mill, on a hilltop overlooking the site. The walls of these structures were higher than those in Structure A, and it is likely that their doorways were closed with wooden doors, shutting out the dangerous particles (see Chapter 7).

There was also a small water canal that entered the site from the north, passing high above Sector A and emptying in Sector B. This canal was fed from water upriver from the mill, which was less likely to have been contaminated. While the canal likely supplied water necessary for the patio process within the main patio of Sector B, clean water could have been siphoned off near prior to its use in the patio below. This again indicates that people residing in Sector B likely had access to healthier drinking and living conditions than those in Sector A.

7.0 Excavation, Features, and Site Occupation

7.1 Introduction

This chapter presents data from the 2018 excavations at the site of Trapiche Itapalluni ("Trapiche"). This includes a detailed description of excavation methods, as well as descriptions of archaeological units, features, and spaces uncovered during excavation. The goal of this chapter is to describe the occupation of Trapiche as well as to detail the variety of activities that took place across the site while it was in use. Special attention is placed on the spatial layout of specific features uncovered during excavation, such as reverberatory furnaces, metallurgical ovens, patios, middens, floors, and cooking hearths. Further detailed information about the artifacts uncovered during excavation is presented in Chapter 8.

The 2018 excavations were directed by myself and my Peruvian colleagues and co-directors Lic. Karen Durand Cáceres and Lic. Jorge Rosas Fernández under the umbrella of the Trapiche Archaeological Research Project (*Proyecto de Investigación Arqueológico Trapiche).* Research was conducted with the permission of the Peruvian Ministry of Culture (authorized by permit RDN 337-2018/DBPA/VMPCIC/MC 2018) as well in collaboration with the local Collacachi and Malcomayo communities.

Our 2018 excavations targeted domestic contexts within the Trapiche refinery. Our intent was to examine the nature of daily life of laborers and overseers by examining the living and working conditions of the site. We investigated if conditions were unequal at Trapiche and how the refinery was provisioned with food and supplies (Cobb 1949; Stern 1993).

This chapters begins with a presentation of results from the surface artifact collection that took place before selecting excavation units, noting any precautions that led to the eventual choice of excavation unit location. A discussion of excavation strategy follows, describing decisions for excavating and naming units, levels, and loci. This is followed by a description of all test units excavated, as well as any horizontal expansions of these initial test units. Many figures and maps are included in this Chapter to indicate where each excavation unit was placed.

7.2 Surface Collection

Prior to 2018 excavations, I visited Trapiche in the summers of 2016 and 2017. During these initial field seasons, I conducted an architectural survey, mapped the site, and conducted a brief surface artifact survey, although I did not collect any artifacts (results are detailed in Chapter 4). Additionally, I spoke with local landowners and gained permission to excavate in the architectural core of Trapiche (we were unable to gain permission to excavate in areas directly north or south of the site core). Upon receiving an excavation permit from the Peruvian Ministry of Culture in the summer of 2018, I returned to Trapiche to collect surface artifacts and locate excavation units. Prior to excavation, we conducted a pXRF soil survey and identified areas to avoid due to heavy metals in soils (see Chapter 6).

Following the pXRF soil survey, we conducted an intensive surface artifact survey at Trapiche, where surface artifacts were identified, mapped, and collected. Project members walked the site of Trapiche in north-south transects, spaced five meters apart, and marked artifacts visible on the surface with pin flags. In cases where straight north/south transects were unable to be completed (i.e., when a building was in the way), project members completed the transect as best they could, looking both inside and outside of the building.

During the surface survey, the site boundary was extended upon the discovery of additional artifact debris, structures, patios, canals, and roads. Following the flagging of artifacts, 2 m x 2 m collection units were placed in locations of dense artifact scatter. “Dense” is defined as 10 or more artifacts within 4 m^2. The location of each collection unit was recorded with a total station (Sokkia SET62W), and all artifacts located within the collection unit were recorded, photographed, and collected (Figure 7.1). Surface artifacts located outside of the 2 m x 2 m collection units were point-plotted using the total station and were recorded and collected individually (Figure 7.2). In total, we recorded 46 collection units.

The majority of surface artifacts were located in Sector’s B, C, and D, and occurred in open patio areas. There were no artifacts found on the surface inside buildings, due to greater accumulation of soil deposits inside these structures, and protection from wind and water erosion. Many of the surface artifacts were located in the patio areas in Sectors B and C, which tested positive for high levels of lead and mercury. Due to this safety concern, we collected the surface objects but did not excavate in these areas. While we found many surface artifacts in Sectors D and E, we were unable to gain permission to excavate in these areas. The only excavation units that were placed on or near positive surface collection units were Units 7 and 8 (Sector B), and Units 23 and 25 (Sector C) (Figure 7.3)

The majority of surface artifacts recorded were ceramics (n=690), followed by animal bones (n=38), lithics (n=16), and metal remains (n=3). Further analysis of the surface artifact assemblage is included in Chapter 8.

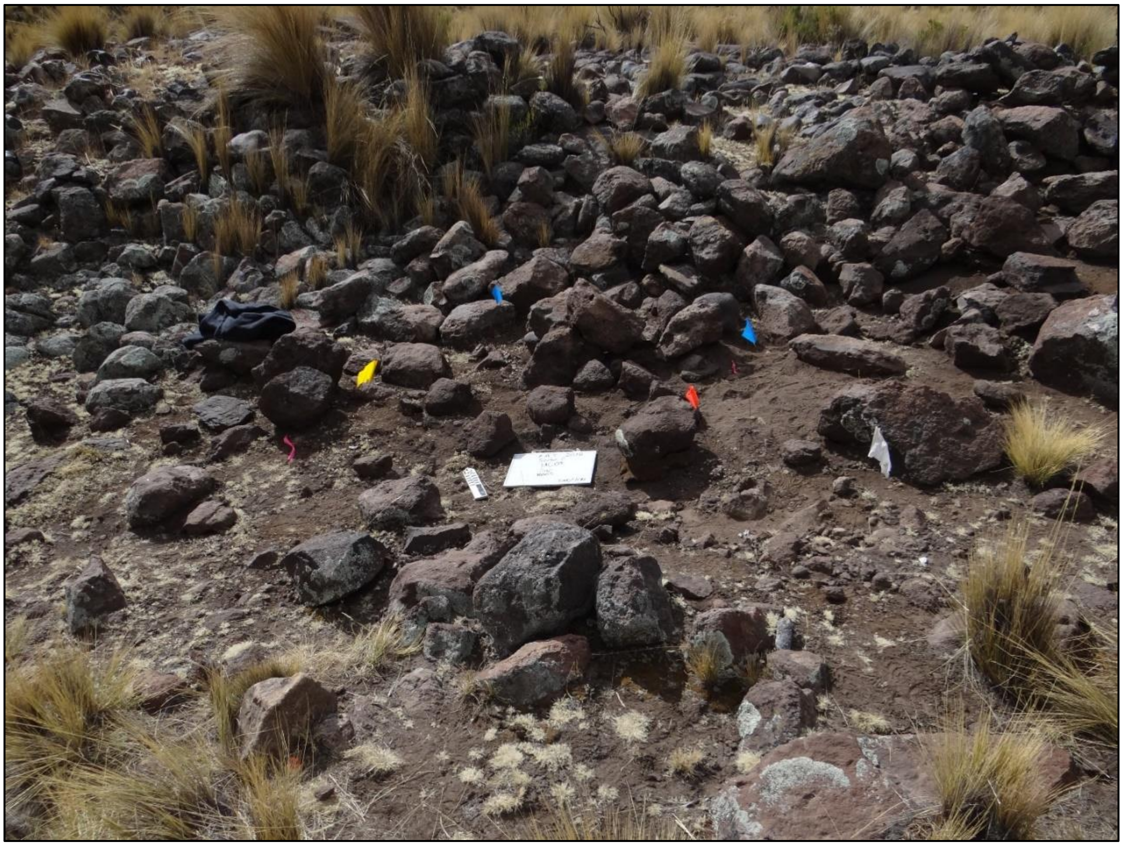

Figure 7.1: Surface collection unit #3, with surface artifact debris marked by pin flags.

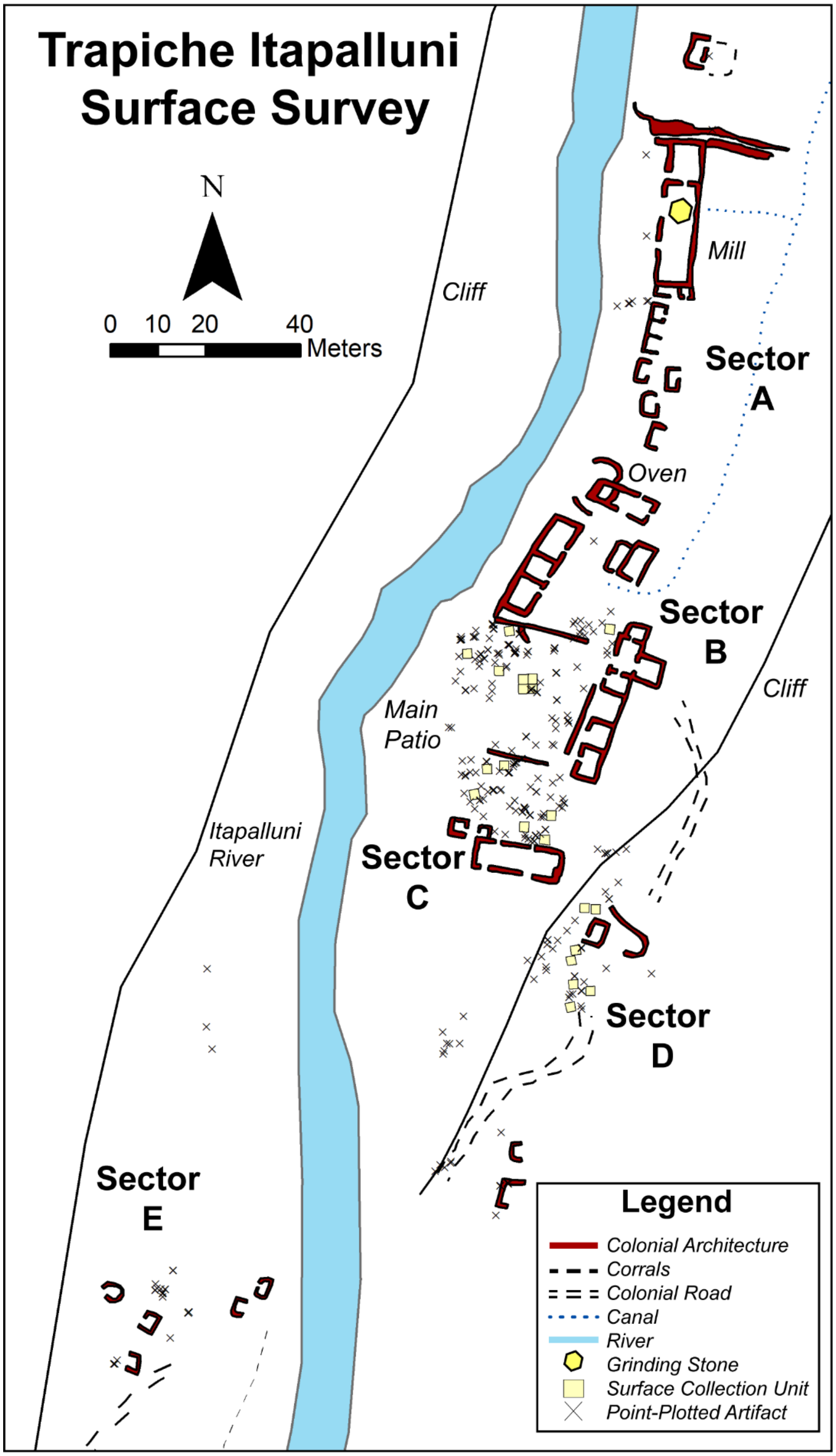

Figure 7.2: Location of surface collection units and point-plotted artifacts.

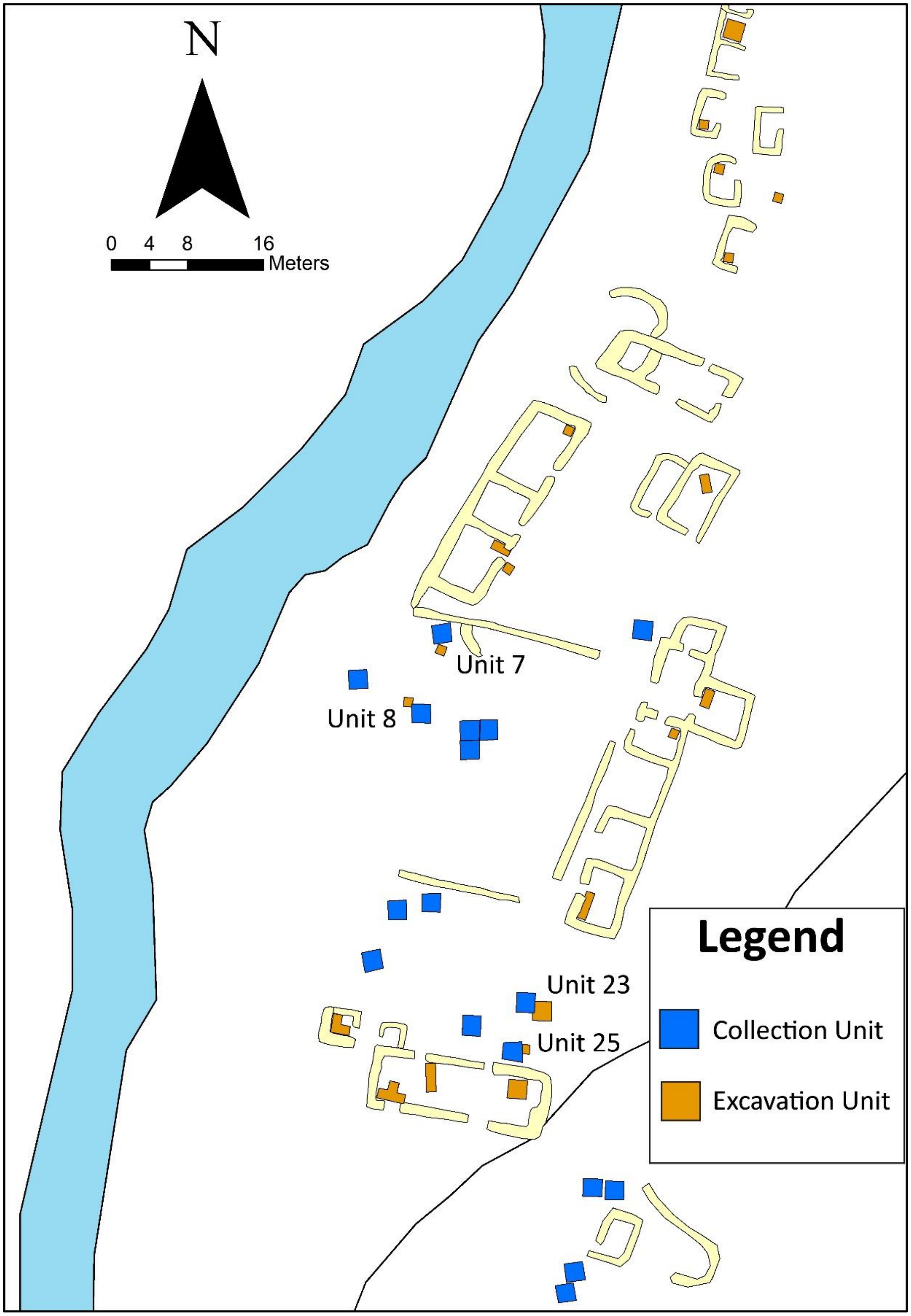

Figure 7.3: Location of excavation units, in relation to surface collection units.

7.3 Excavation Procedures

7.3.1 Excavation

Following surface artifact collection, we decided to excavate within the architectural core of Trapiche in Sectors A, B, and C. The excavation strategy concentrated on the recovery of ceramics, lithics, and food remains from domestic areas, patios, and trash middens. We employed a two-step targeted excavation strategy, initially excavating a series of 1 m by 1 m test units across the site, and then expanding selected units in horizontal excavations, focusing on domestic areas.

The designation of “unit” (*unidad de excavación*, or “UE”) was given to each horizontal space chosen for excavation. Because we began excavations with 1 m by 1 m test units, each initial test unit was 1 m^2 in size. We excavated 20 total 1 m by 1 m test units during the first phase of the 2018 excavation season. Test units were numbered in sequential order as they were excavated, from Units 1- 25. Some numbered units did not end up being excavated due to heavy metal contamination (e.g., Units 1, 2, 3, 5, and 22) and their numbers were not reused.

Expanded units were not assigned new numbers but rather were given extensions labeled “squares” (*cuadriculas*, or “cuad”) for every 1 m^2 square extension. For example, when test unit 11 was initially expanded by one 1 m x 1 m square, that expansion was given the designation UE 11, Cuad 1. It was expanded by two more 1 m x 1 m squares, which were labeled Cuad 2 and Cuad 3. The total area excavated in Unit 11 was 4 m^2. The initial 1 m x 1 m test unit for Unit 11 was not given a Cuad number and was referred to as “Cuad 0” (Figure 7.4).

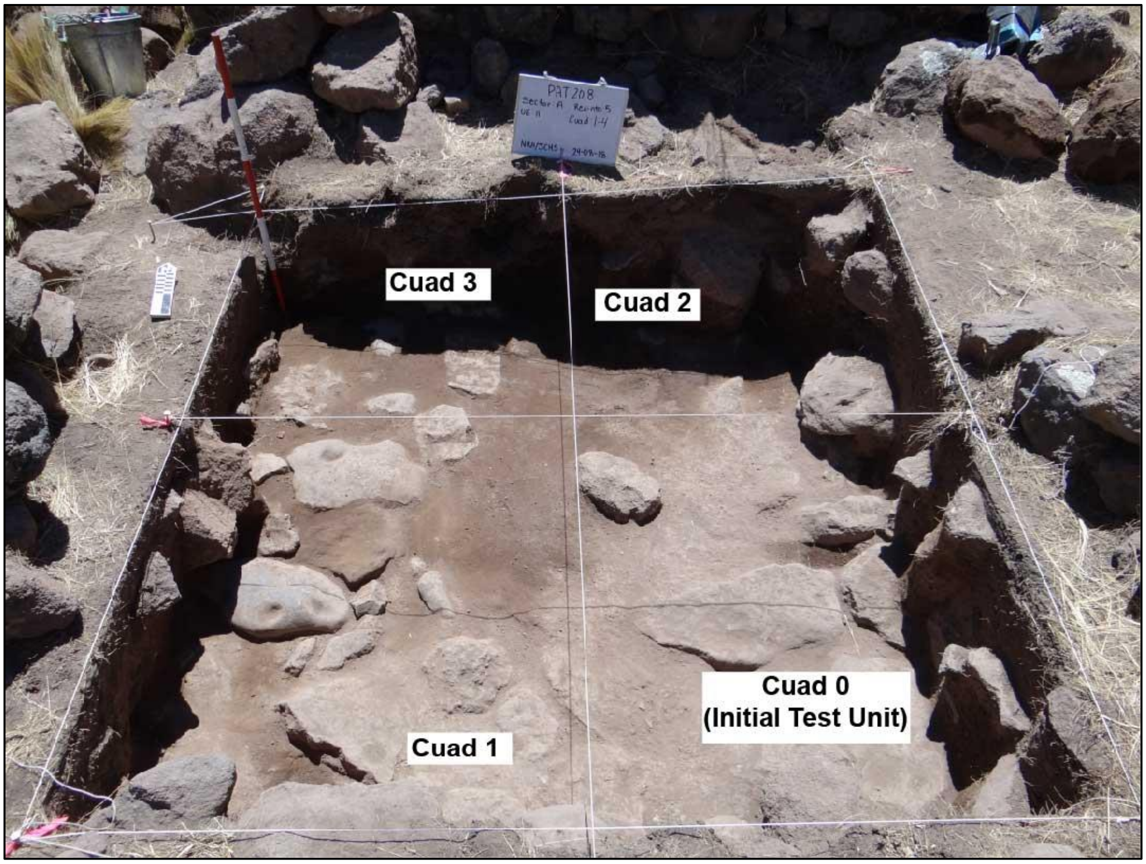

Figure 7.4: Unit 11 with the original test unit located in the SE grid.

Excavation of test units and larger units used a single context (locus) recording system, defined as a distinct volume of matrix and its artifacts. This recording strategy is useful in historical archaeology contexts for recording subtle differences in domestic stratigraphy. Each locus was registered on a unique locus recording sheet during excavation and assigned a unique number. The identification and declaration of "loci" allows the basic elements of deposition to be excavated in chronological order that corresponds in a general way to the historical deposition processes at the site. The objective of maintaining unique loci was both analytical and organizational, as it allowed for the organization of excavation data in a coherent, stratigraphic way. The loci registration scheme was a form of a modified Harris matrix which facilitated the analysis of current stratigraphy with attention to differentiating evidence of domestic events.

7.3.2 Screening, Flotation, and Soil Sampling

All deposits were screened through 1/4” mesh and artifacts were separated by material class for subsequent laboratory analysis. When possible, artifacts were mapped in situ to reflect household activity patterns before being removed. To facilitate faunal and botanical analysis, 8 to 10-liter bulk flotation samples were systematically collected. When 10 L of excavated sediment was not available, we sampled the entire locus. Each bulk sample was then processed through water flotation using an SMAP-type mechanized float machine (Figure 7.5). The heavy fraction was later hand-separated through graduated sieves at the field laboratory (4 mm, 2 mm, 1 mm, and 0.5 mm), and the light fraction was sent for further palaeobotanical analysis.

Figure 7.5: Project archaeologist Virginia Beatriz Incacoña Huaraya floating soil samples on the SMAP flotation machine.

7.4 Test Units and Expansions

To locate units in domestic spaces, we used the results of the pXRF survey in combination with architectural information and surface artifact data. In total, we excavated 20 test units (20 m^2) during the initial phase of the 2018 excavations. Units 1, 2, 3, and 5 in Sector A and Unit 22 in Sector C were intended for excavation but tested positive for hazardous levels of mercury and lead and were not excavated. Their numbers were not reused.

In total, we placed 25% (n=5) of the test units in Sector A, 45% (n=9) in Sector B, and (30%) (n=6) in Sector C. The lower representation of units in Sector's A and C were due to soil contamination results preventing further unit placement. Units were placed both inside and outside of structures, with 70% (n=14) inside structures, 20% (n=4) in patios, and 10% (n=2) in middens. The lower representation of units outside structures was again due to higher soil contamination results. Soil contamination greatly affected our sampling strategy, limiting our excavation in patios and metallurgical activity zones.

Based on the results of the test units, we selected eleven units to expand for larger areas of horizontal excavation (Table 7.1, Figure 7.6). Only one unit in Sector A (Unit 11) was selected for further excavation. This was due to the lack of cultural material in the other test units in Sector A. Unit 11 was located within a laborer household and included the remains of a hearth, stone floor, burnt bones, jewelry, and a spindle whorl.

In Sector B, we selected four units (Units 14, 16, 17, and 19) to expand, all of which were located within structures. Test units in patios in Sector B did not recover cultural material. Unit 14 and Unit 16 were located within metallurgical/storage buildings, while Unit 17 and 19 were located within higher-status, administrative buildings. Unit 19 was located within the possible household of the refinery owner and/or overseer, and it contained scattered remains of higher-status trash and debris, as well as a silver coin.

In Sector C, we selected all six test units to expand (Units 13, 20, 21, 23, 24, and 25) due to high levels of domestic material in all test units. Four of these units (13, 20, 21, and 24) were located within structures, while two (23 and 25) were located within the communal midden.

The total area of the horizontal extensions at Trapiche was 22 m^2. When combined with the initial test unit area of excavation (29 m^2), the grand total of area excavated at Trapiche for the 2018 field season was 42 m^2. Figure 7.7 provides more information about unit locations.

Table 7.1: Trapiche 2018 Excavation Units.

Unit	Sector	Context	Size	Initial	Extension	Total Area	Comments
1	A	Mill	-	-	-	-	Not excavated
2	A	Mill	-	-	-	-	Not excavated
3	A	Mill	-	-	-	-	Not excavated
4	A	Patio	1m x 1m	1 m²	-	1 m²	-
5	A	Furnace	-	-	-	-	Not excavated
6	B	Patio	1m x 1m	1 m²	-	1 m²	-
7	B	Patio	1m x 1m	1 m²	-	1 m²	-
8	B	Patio	1m x 1m	1 m²	-	1 m²	-
9	A	Structure	1m x 1m	1 m²	-	1 m²	-
10	A	Structure	1m x 1m	1 m²	-	1 m²	-
11	A	Structure	2m x 2m	1 m²	3 m²	4 m²	-
12	A	Structure	1m x 1m	1 m²	-	1 m²	-
13	C	Structure	2m x 2m	1 m²	3 m²	4 m²	-
14	B	Structure	1m x 2m	1 m²	1 m²	2 m²	-
15	B	Structure	1m x 1m	1 m²	-	1 m²	-
16	B	Structure	1m x 2m	1 m²	1 m²	2 m²	-
17	B	Structure	1m x 2m	1 m²	1 m²	2 m²	-
18	B	Structure	1m x 1m	1 m²	-	1 m²	-
19	B	Structure	1m x 3m	1 m²	2 m²	3 m²	-
20	C	Structure	2m x 2m	1 m²	3 m²	4 m²	-
21	C	Structure	1m x 3m	1 m²	2 m²	3 m²	-
22	C	Patio	-	-	-	-	Not excavated
23	C	Midden	2m x 2m	1 m²	3 m²	4 m²	-
24	C	Structure	1m x 3m	1 m²	2 m²	3 m²	-
25	C	Midden	1m x 2m	1 m²	1 m²	2 m²	-
			TOTALS	**20 m²**	**22 m²**	**42 m²**	

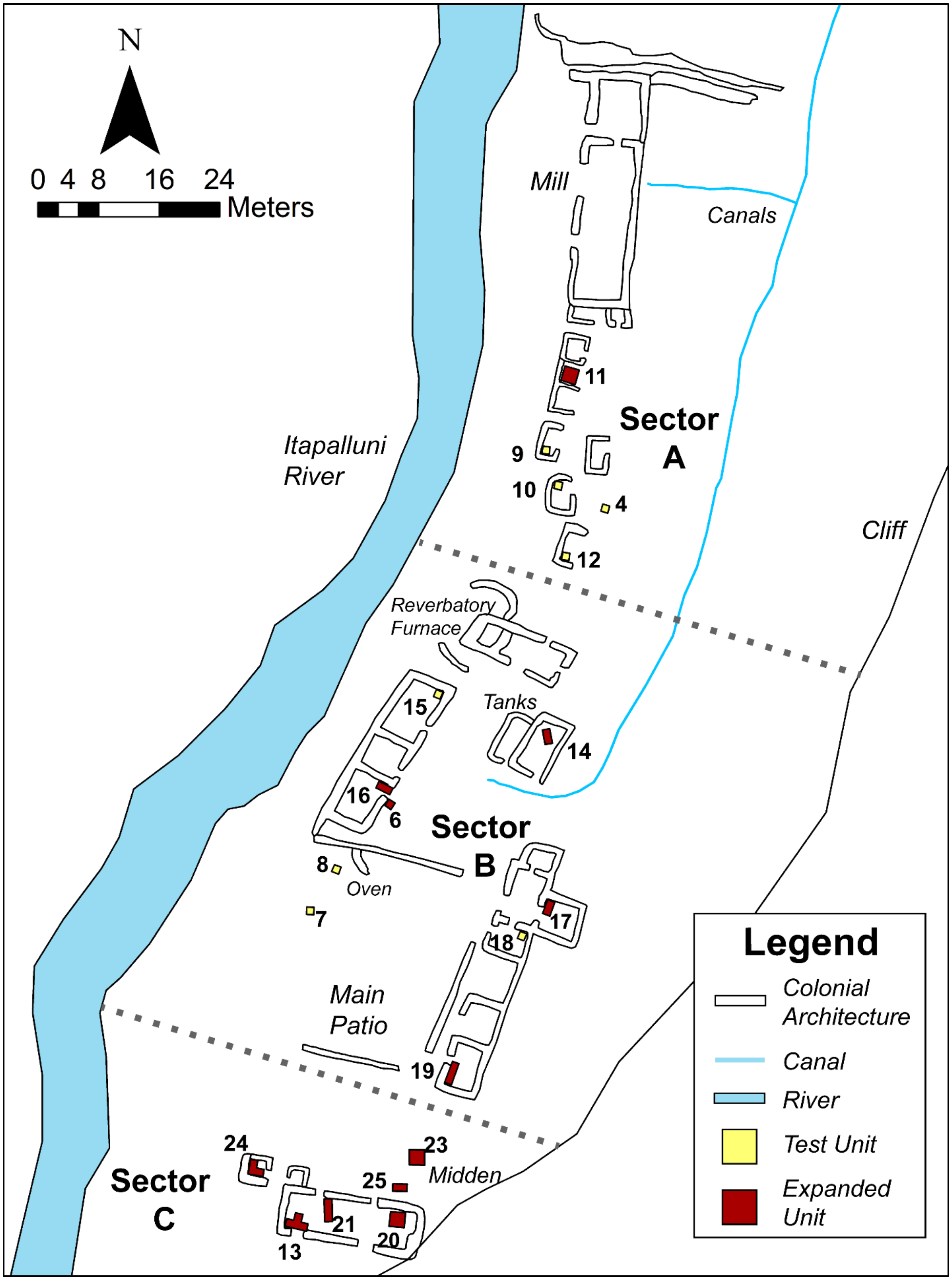

Figure 7.6: Excavation units within the architectural core of Trapiche.

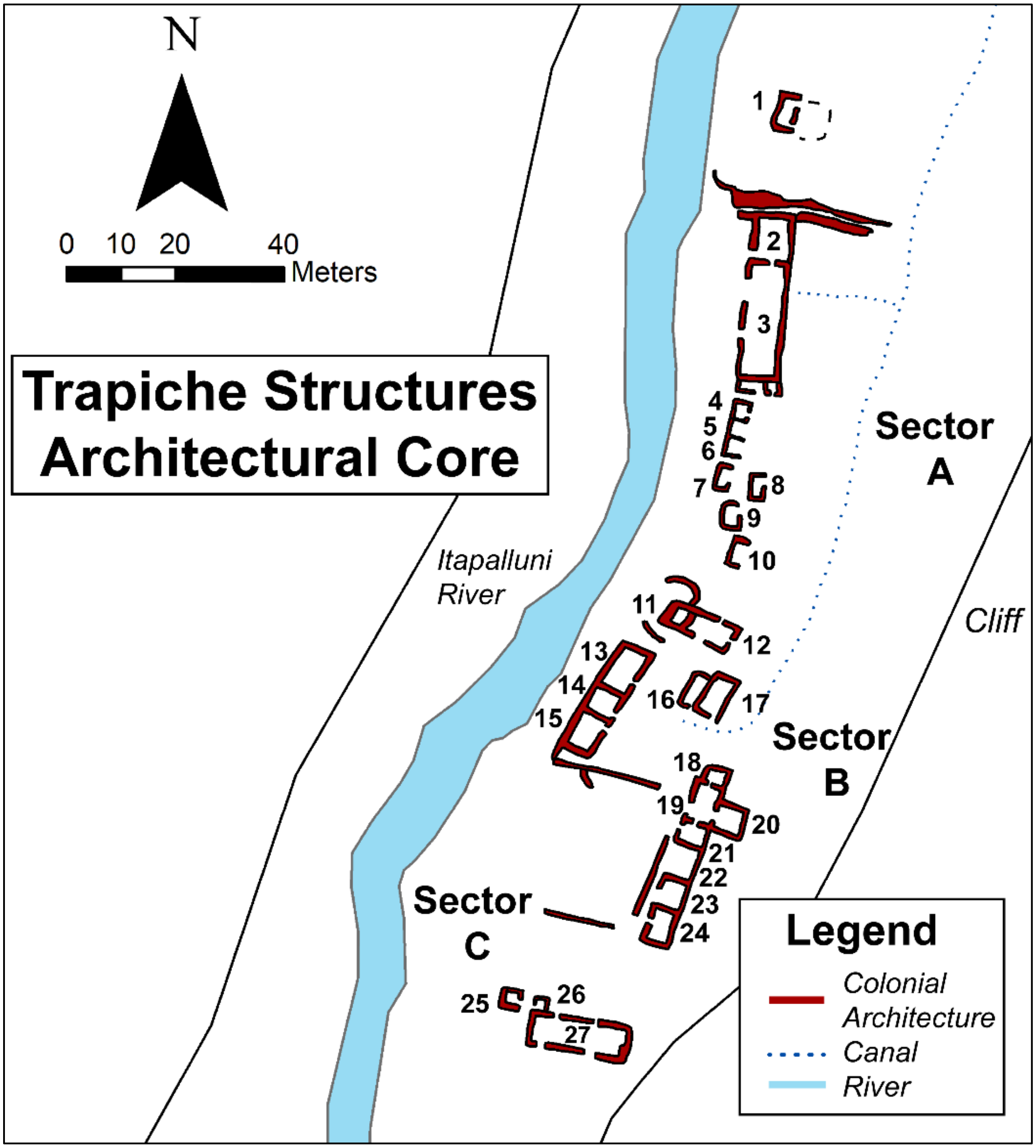

Figure 7.7: Numbered structures at Trapiche.

7.5 Sector A Excavations

7.5.1 Sector A Households

One of the primary goals of excavation was to determine the function of the small, poorly built structures in Sector A, located directly south of the mill. There were seven total small structures in Sector A, not including the mill and its attached storage structures (see Figure 7.7). These structures were all built in a similar square pattern, with all their doorways facing east, possibly toward a rising sun, away from cold winds, and opposite from toxic smoke and dust from the refinery mill and ovens.

To learn more about these small structures, we placed four test units (Units 9, 10, 11, and 12) within these buildings (see Appendix C for complete excavation unit summaries). In three of the test units (Units 9, 10, and 12), we identified a one-time occupation with a compacted dirt floor in each of the buildings (Figure 7.8). These three buildings (Structure 7, 9, and 10) also had the remains of similar painted domestic pottery and serving bowls and plates located in a context directly on top of compacted dirt floors (Figure 7.9). We excavated until sterile soil in all three units, and the average depth of these units was 70 cm below surface. Surface soil accumulation was great inside these structures, and averaged 28 cm. There was also building collapse underneath the surface soil, with large stones from the structure's walls overlying the cultural deposits.

We did not recover the remains of hearths, benches, or stone floors within Units 9, 10, and 12, nor did we recover remains of lithic tools or food refuse. Further, there was no indication of multiple periods of occupation within these structures. Contexts below each compacted dirt floor consisted of natural alluvial deposits and sterile soil. Therefore, these structures were likely used for short-term sleeping barracks for workers at the site, as well as storage. Their lack of material highlights the interim nature of work at Trapiche, as laborers likely cleaned and took all their possessions with them after a brief, 3-4 month stay at the site.

Because of their limited occupation, Sector A structures may have been built later in the site's history, as they show no signs of remodel or long-term occupation. Most ceramics recovered from these structures were serving bowls and plates (for more detailed analysis, see Chapter 8), and it is likely no cooking and food processing occurred there.

Figure 7.8: The compact dirt living floor inside Unit 9, Sector A (Locus 57).

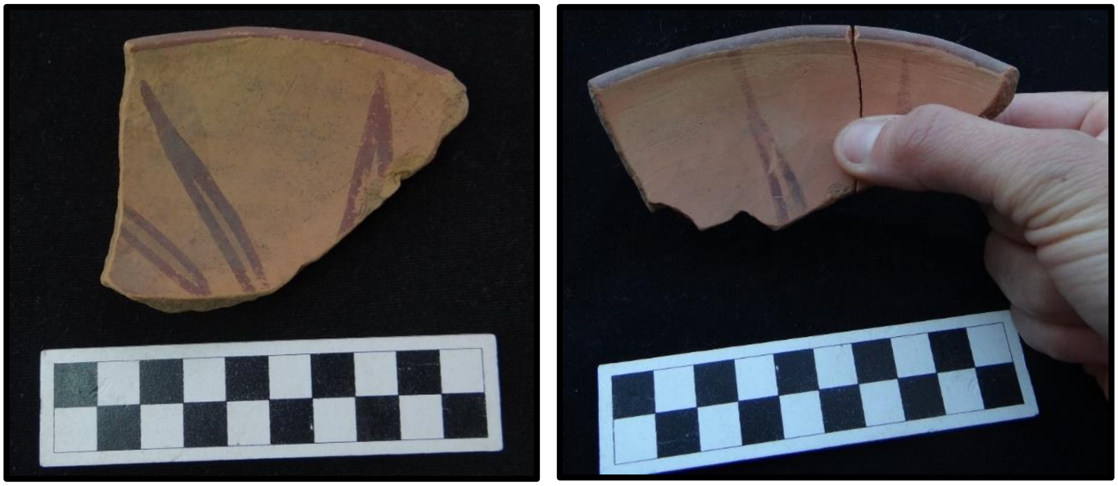

Figure 7.9: Painted colonial serving bowl fragments from Sector A. (Left) Unit 9 fragment and (Right) Unit 10 fragments.

A fifth test unit, Unit 11, was placed inside Structure 5 in Sector A. Structure 5 shared a northern and southern wall with two additional structures that were not excavated. We chose to excavate within this middle structure in hopes of finding the remains of a cooking hearth, which we did indeed locate. Stratigraphy inside Unit 11 was very similar to the other Sector A structures, with considerable deposition of surface soil (22 cm) inside the building, as well as a large amount of rock-wall collapse (32 cm). These levels had very few artifacts and overlaid the occupational level of the unit.

Unit 11 differed from the other Sector A structures because it had a stone floor, instead of a dirt floor, below the wall collapse. The stone-line floor covered the southern half of the structure. On top of the stone floor, we recovered a wide array of ceramics, lithics, and food refuse. Artifacts included manos and metates for grinding food, as well as a spindle whorl for spinning thread from wool, and a decorative bead (Figure 7.10). The remains of the stone floor, in conjunction with the hearth and the vast array of domestic remains, indicates that Structure 5 was a location for cooking and processing food at Trapiche. It may have also been used for living and sleeping, although the two attached, unexcavated buildings to the north and south of Unit 11 may have been more likely to have been used as living quarters/sleeping barracks.

Due to its proximity to the mill, Structure 5 would have been quite noisy and dusty throughout the day and night (during boom periods, silver refineries routinely operated throughout the night). Because living conditions would have been quite poor, it is possible that Structure 5 was originally used as storage when the grinding mill was running and was only converted to a domestic space when metallurgical practices shifted over time. However, poor living conditions for laborers were routine in colonial silver refineries (Robins 2011, 2017), so it is likely that the structures in Sector A were occupied by laborers throughout the entire use of the mill.

Sector A structure doorways are all located on the east side, away from a north-westerly wind common in the area. This would have provided some protection from the dust coming from the mill. The doorways also faced the early morning sun, and because the refinery was used in the rainy, summer season, the eastern-aspect would have generated quite a lot of heat in the morning.

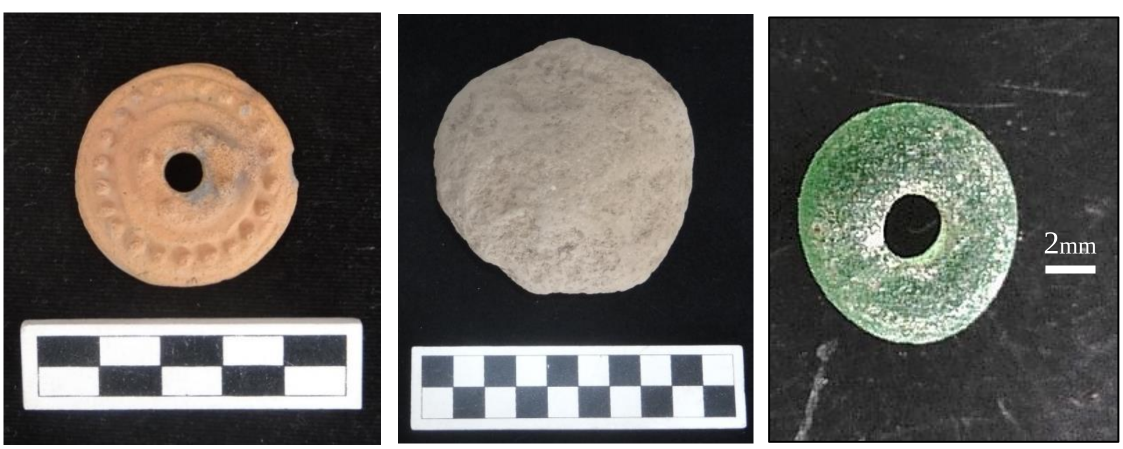

Figure 7.10: (Left to right): A spindle whorl, a grinding stone, and a small decorative bead recovered from on top of the stone floor in Unit 11.

7.6 Sector B Excavations

7.6.1 Sector B Storage Buildings

Units 15 and 16 were placed within two large, administrative buildings directly south of the reverberatory furnace in Sector B, near the river (Structures 13 and 15). Their doorways faced east, toward the internal patio. In both units, we uncovered dirt floors below the surface soil and wall collapse. The surface of the floors was made of a mixture of dirt and red clay and the floors were hard and compact. These floors appeared to have been more planned than those in Sector A, as we found evidence of floor preparation by filling the ground with a mix of river cobbles, dirt, and clay before constructing the flat living floor. This would have required more time and energy to build, likely signaling the increased importance of these buildings. We uncovered a lead musket ball, likely used with an arquebus, in Unit 16. This artifact may indicate a location of weapon and arms storage for the site. It also may indicate the location of mercury and silver storage, as it was common to place a guard or locked door to protect these important assets.

There was no indication of earlier floors or occupation below the floors we uncovered, as we found sterile soil below the living floors (Figure 7.11). Unit 15 was excavated to 70 cm in depth, and Unit 16 was excavated until 50 cm in depth. Similar to Sector A structures, both units had considered levels of topsoil deposition on their surface (23 cm and 28 cm), likely due to their protected nature inside the structures.

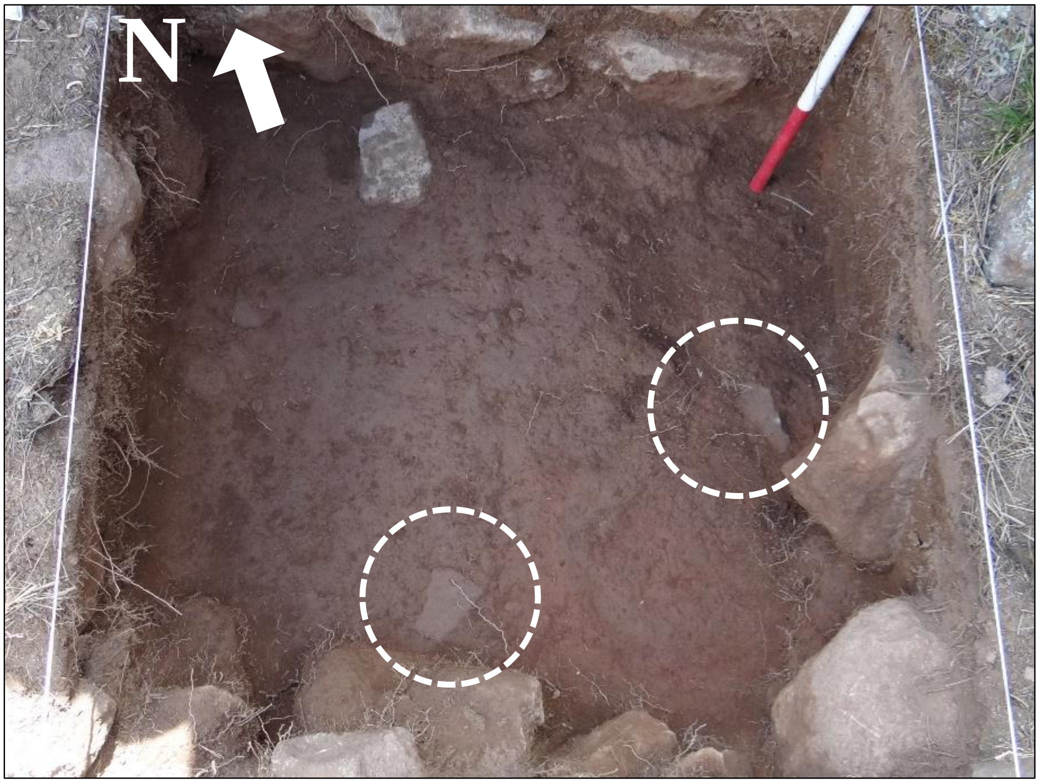

Figure 7.11: Unit 16's compact, dirt floor with inclusions of clay and ceramics from Locus 91. Ceramics are circled in white.

7.6.2 Sector B Administrative Buildings

In addition to dirt and stone floors, we also uncovered white plaster floors similar to plaster we found on some walls of Sector B buildings (Figure 7.12). This white plaster was likely made with lime, which was then mixed with water and sand. Within Units 17 and 18 (Structures 20 and 21), the only discernable occupation period was a compacted, white plaster floor (Figure 7.13). We found very little material inside either of these structures, indicating their possible use for administrative tasks, such as weighing and measuring bars of silver, or keeping track of operation costs. Plaster floors were only found in four units at Trapiche (Units 13 and 21, in addition to Units

17 and 18). These may be a marker of status or specialized activities areas. Units 13 and 21 were location in Sector C, Structure 27, the possible chapel.

Unit 17 was excavated until 75 cm, and Unit 18 was excavated until 76 cm in depth. Again, both were inside structures, meaning they had accumulated a large topsoil layer (15 cm and 19 cm), as well as a large amount of stone wall collapse (until 52 cm and 39 cm). The plaster floors were found below the rock wall collapse. There was only sterile soil below the floors.

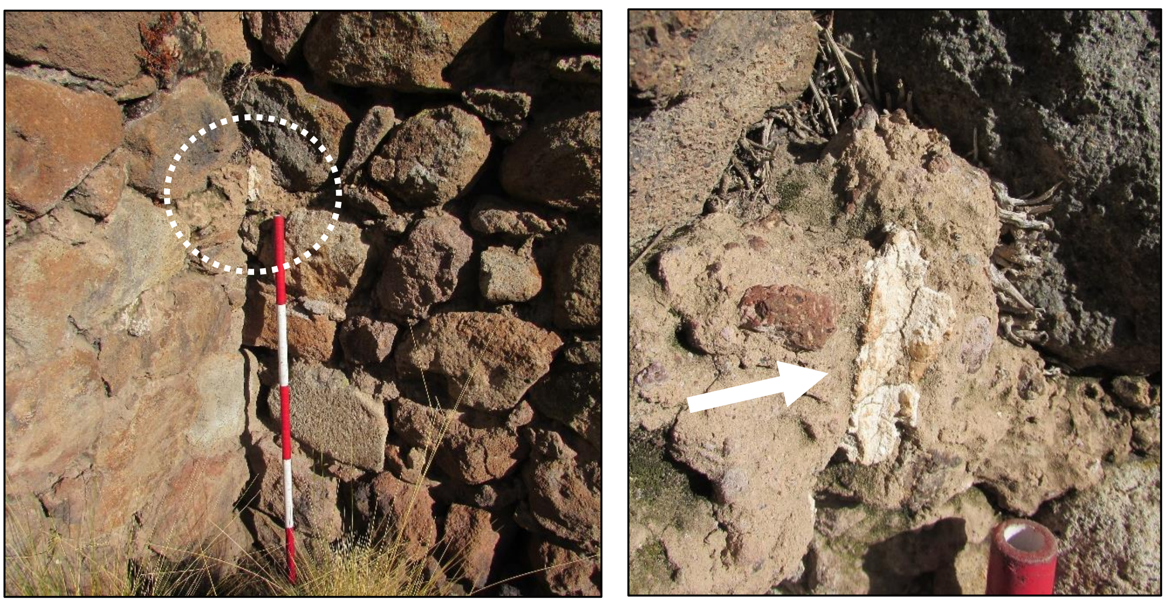

Figure 7.12: (Left) The southeast corner of Structure 19, Sector B. (Right) Zoomed in view of the mud plaster wall, covered by white lime plaster.

Figure 7.13: (Left) Unit 17's compacted floor with specks of white lime plaster, and (Right) Unit 18's plaster floor, still visible in the NE corner of the building.

7.6.3 Sector B Households

Unit 19 was placed inside Structure 24, located on the east side of Sector B, away from the central work patio and on top of the sloping hill that overlooks the site. Structure 24's doorway faced west, with an unobstructed view of the work patio below. Similar to the other Sector B structures, we excavated until a depth of 77 cm. Again, topsoil (11 cm) and rock wall collapse (until 40 cm) accounted for much of that soil depth.

Below the rock wall collapse, we uncovered a compacted, dirt floor. On top of the floor, we found a wide collection of domestic and higher-status materials. In the southwest corner of Structure 24, we found remains of domestic trash and a small midden (Figure 7.14). We also found the remains of adobe mud bricks. Additionally, we found higher-status ceramics, as well as personal items such as a *tupu* shawl pin and a silver *medio real* coin. Below the floor, we found evidence of preparation, similar to Units 15 and 16 (filled ground mixture with cobbles and dirt, to make the floor level). We found no evidence of an earlier occupation below this level.

Unit 19 had many more artifacts than the other units excavated in Sector B, signaling a potentially different use for Structure 24. The combination of domestic artifacts, food remains, and higher-status personal artifacts likely indicates this structure was used by an overseer or possibly the owner of the refinery (someone of importance).

Figure 7.14: Unit 19's prepared dirt floor (white dotted line). The location of the midden is circled in red.

7.6.4 **Sector B Mercury Oven**

In addition to the units we placed within structures in Sector B, we placed Units 7 and 8 inside the main work patio to gain more information about the refining process. Both units were located near surface collection units 17, 18, and 19, which had a combined 73 artifacts recovered on their surfaces. We chose to place Units 7 and 8 near these locations, hoping that the surface artifact scatter would indicate presence of artifacts below the surface as well.

Prior to excavating, we tested the soil of Sector B's patio area for high levels of mercury and lead with our pXRF survey (see Chapter 6). We made sure to place Units 7 and 8 in locations that registered low levels of heavy metals recorded from the survey. We also mitigated risk to workers by requiring excavators to take turns excavating and screening within these units, and no one single team member excavated for long periods. Unit 7 did not recover any ovens or cultural material. However, Unit 8 uncovered a mercury oven, with burned bricks, a stone floor, and a large amount of mercury pot fragments (Figures 7.15 and 7.16).

The stratigraphy in Units 7 and 8 differed from the units placed within Sector B households. There was less topsoil accumulation, and no rock wall collapse. We excavated Unit 7 until 52 cm, and Unit 8 until 44 cm in depth. Below the thin topsoil layer, both units had layers of grey, ashy soil, signaling the nearby oven. Unit 7 was placed south of Unit 8, and we did not uncover any artifacts or features in this unit. It was likely just part of the work patio and may have been a location where water tanks were stored, or where the mercury/silver amalgam was heated and mixed (see Chapter 2 for a more detailed discussion of refining techniques).

Unit 8 differed from Unit 7 in that below the level of ash, we continued to uncover artifacts and evidence of an oven. We found a large collection of ceramics, animal bones, and large pieces of burned clay. We also uncovered burned camelid dung (*taquia*), indicative of a fuel source for an oven. Below a thick layer of broken ceramics, we uncovered a stone-lined floor, which was likely the base of the oven.

The oven found in Unit 8 was likely a mercury oven, used to preserve and recapture mercury that was used in the patio process. The majority of the pots we recovered in Unit 8 were large, open-mouthed pots with wide rims (see Chapter 8 for a more detailed analysis). We also recovered perforated ceramic lids that were likely used during the mercury re-uptake process. The high levels of mercury and lead in the soils of Sector B, in addition to the mercury oven in Unit 8, indicate that there were likely multiple mercury ovens used in the patio, with at least one in operation at all times (Robins 2011). Because mercury was expensive and was often imported to the Puno Bay, the recovery and reuse of mercury would have been very important to refinery operators. In these small ovens, ore bodies containing mercury were heated, and the mercury was vaporized and collected after it condensed and returned to its normal state.

Alvaro Alonso Barba includes a description of mercury collection and reuse in *Arte de los Metales.* Refiners first buried large, empty pots in the ground in a square oven (Figure 7.17). Then, they built a three-sided wall of adobe bricks and stones around the buried pots to contain the fuel (Barba 1640:97r). After building the oven, chamber pots (*orinales*) with small necks were filled with ore byproducts, and then ceramic lids with perforations were placed over the chamber pot's opening. The chamber pots were then inverted and placed on top of the buried pots, likely secured together with rope. Kindling was then placed on top of the buried pots and lighted. After enough heat formed, the mercury within the chamber pots vaporized, and later condensed and fell through the lids on the inverted chamber pots, collecting in the bottom of the vessels (Barba 1640:97r-98r).

Figure 7.15: (Left) Unit 8 mercury oven during excavation and (Right) at the end of excavation. The white line represents the stone wall of the furnace.

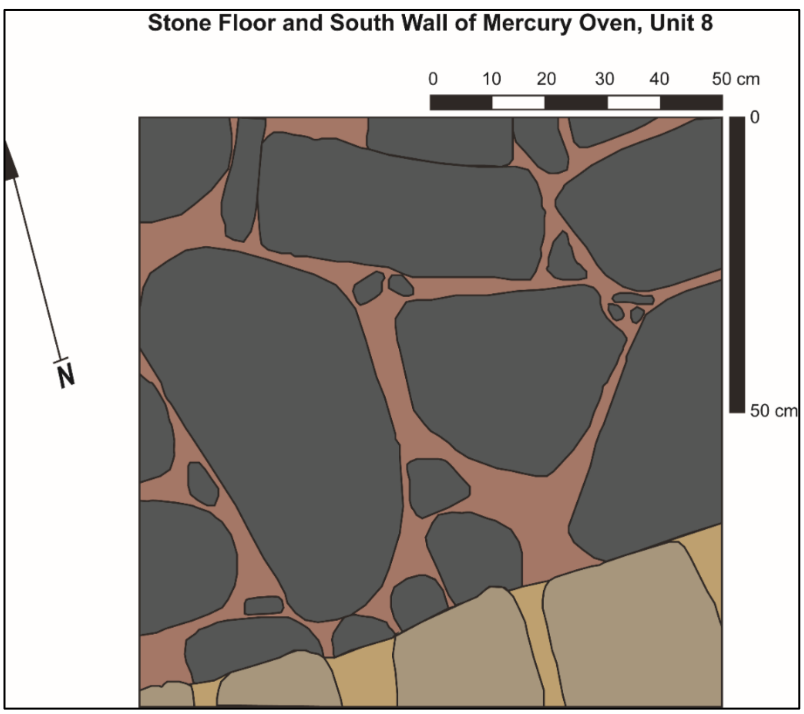

Figure 7.16: A drawing of the stone floor found at the bottom of Unit 8.

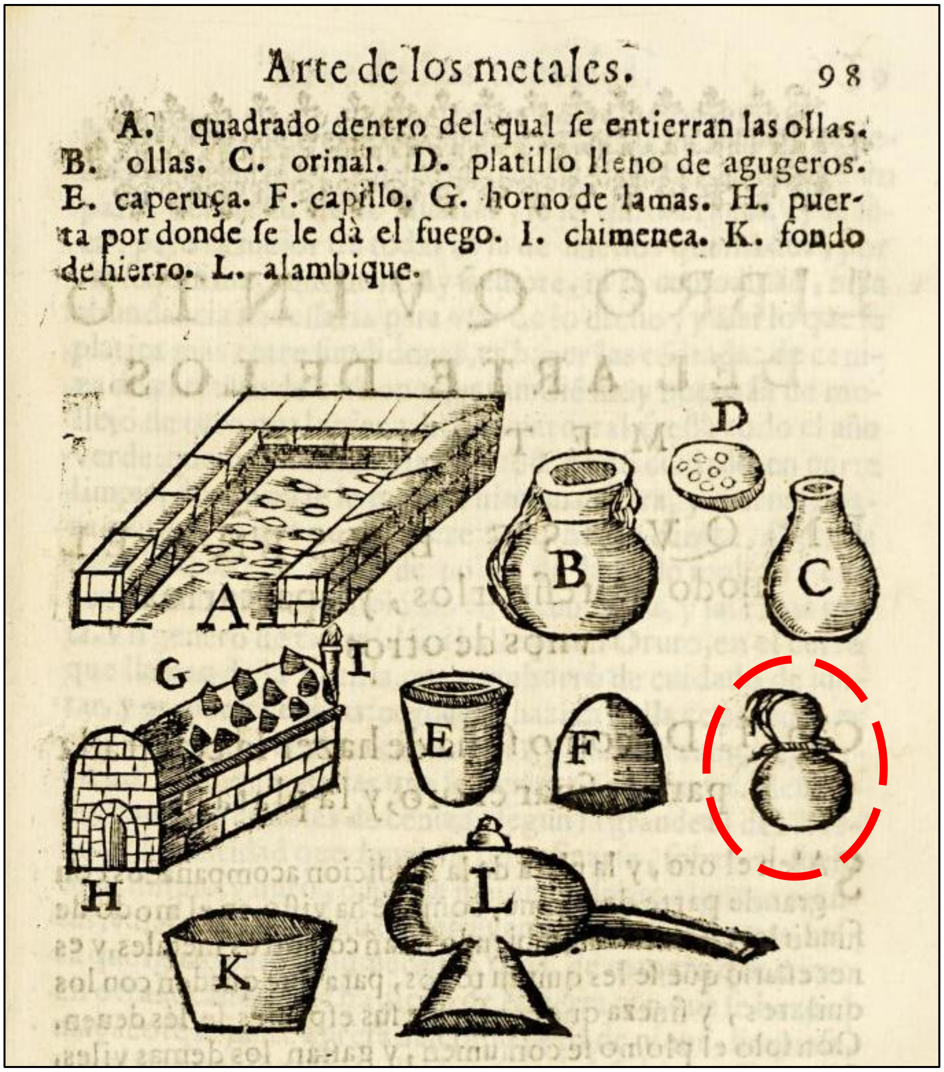

Figure 7.17: Barba's drawing of mercury reuse (Barba 1640:98r).

The descriptions from Figure 7.17 are as follows: A) The oven where pots are buried; B) large pot to be buried; C) chamber pot without lid; D) perforated lid; E) retort; F) hood; G) flame furnace; H) fire door; I) chimney; K) iron vessel; and L) condenser head. The unlabeled figure, circled in red, depicts the inverted chamber pot on top of the large pot.

7.7 Sector C Excavations

7.7.1 Sector C Households

Unit 24 was placed inside Structure 25, a small, rectangular building located northwest of Structure 27 (the chapel). Structure 25 was the only structure at Trapiche to have two, symmetrical wall niches (Figure 7.18). Stratigraphy inside Unit 24 included a thick layer of topsoil and rock-wall collapse, similar to other units in Sectors A and B placed inside structures. Due to this thick level (34 cm), the depth of this unit extended until 107 cm, when we hit sterile.

Unit 24 stratigraphy differed from other structures at Trapiche in that below the surface topsoil and wall collapse, we found a significant fill event on top of the living floor. The fill, roughly ~20 cm deep, was a mix of loose soil, clay, charcoal, small rocks, and a variety of artifacts, including ceramics, animal bones, and metals. Below the fill, we uncovered a compacted dirt floor, with many inclusions of charcoal and flat artifacts. We also found a small cooking hearth in the southwest corner of the unit (Figure 7.19 and 7.20). Below the compacted floor, we found evidence of floor preparation (again, similar to Units 15, 16, and 19). This level had relatively few artifacts, and below the floor preparation we found sterile soil.

Excavations in Unit 24 reveal that Structure 25 was likely used as domestic quarters early on. This may have been the residence of the chapel's caretaker, or a caretaker in charge of a central storage depot for important goods coming in and out of the site. In the final occupation of Trapiche, Structure 25 appears to have been used as a trash dump, indicating changing uses for Sector C. Unit 24 had at least two different occupation events.

Figure 7.18: Unit 24 prior to excavation, with wall niches visible on the western wall.

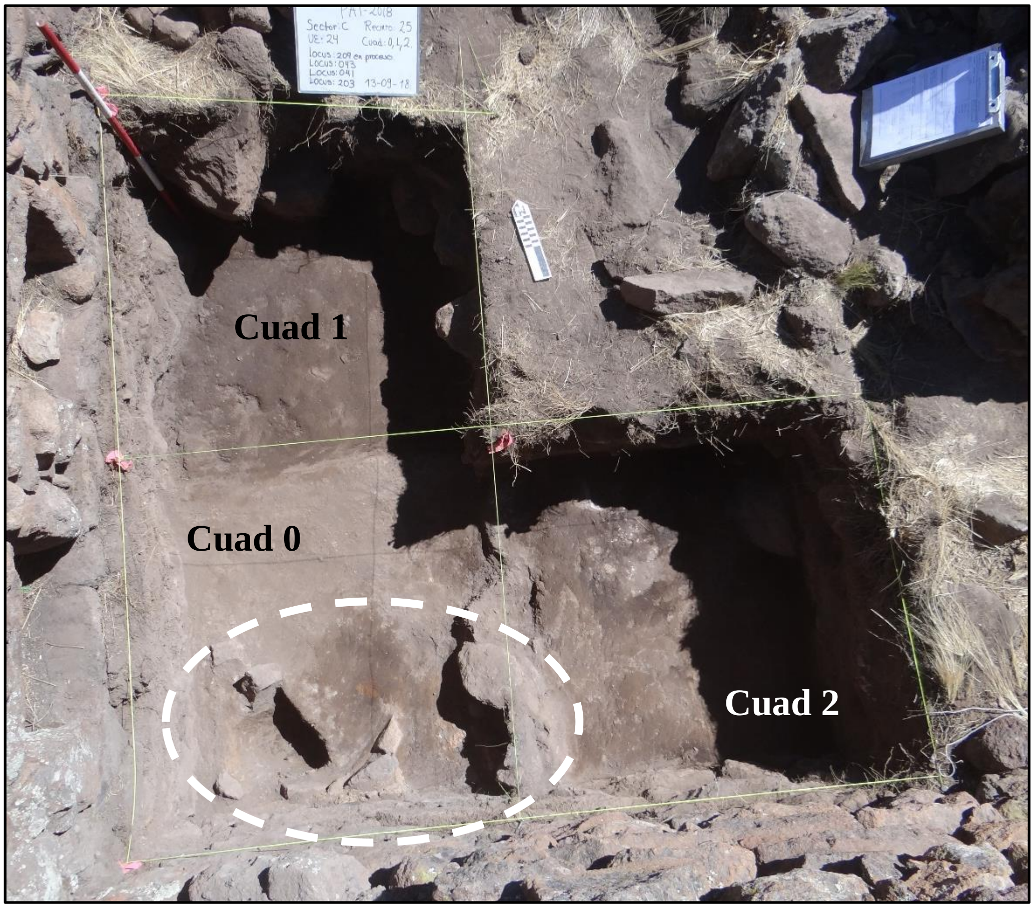

Figure 7.19: Unit 24's dirt floor and hearth (indicated by white dashed circle).

Figure 7.20: Close up of Unit 24's hearth. (Left) fully excavated hearth, and (Right) the hearth in the process of excavation.

7.7.2 **Sector C Chapel/Multi-Use Building**

Units 13, 20, and 21 were placed inside Structure 27, the large chapel/multi-purpose building at the southern end of the site. These excavations revealed multiple occupation periods with dirt, plaster, and stone floors (Figure 7.21). Phase 1 represents the earliest occupation. Phase 2 shows an addition of a lime plaster floor. Phase 3 includes the addition of a stone-lined floor. Phase 4 includes building extensions and another dirt floor. These phases indicate Structure 27 was in use throughout various periods, and its use changed over time. The only other structure to have had multiple occupations at Trapiche was Structure 25, inside Unit 24, also in Sector C.

Unit 20 was placed in the eastern most portion of Structure 27, which appears to have been added in the final phase of occupation. It was placed here to determine if Structure 27 was ever used as a chapel, as the eastern section of the building sat on an incline and resembled an elevated altar[15]. We recovered very little material in Unit 20, and hypothesize it was added later, possibly for increased storage space. The stratigraphy in Unit 20 was very basic, with a thick layer of topsoil, which quickly lead to bedrock. We only excavated 39 cm in depth and encountered bedrock in all the extensions associated with Unit 20. While Unit 20 did not uncover an altar, this did not rule out the possibility that Structure 27 was once used as a chapel.

Units 13 and 21 were placed in the western portion of Structure 27. Unit 13 was located in the southwest corner, while Unit 21 was located near the northwest entrance. Both units revealed similar stages of occupation and floor construction. Unit 13 was excavated until 59 cm in depth, and Unit 21 was excavated until 72 cm of depth. Unit 21 excavations were deeper because we decided to dig past sterile to be sure there were no other floors, or deeper burials, below the

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[15] Catholic chapels built during this period were laid out in an east-west orientation, with the altar and the apse placed in the eastern end.

structure. Like all the units excavated inside structures at Trapiche, Units 13 and 21 both had thick topsoil levels (~20 cm), as well as wall collapse (until ~40 cm). These levels overlaid various fill events, middens, floors, and features.

From earliest to latest, the floors uncovered in the western side of Structure 27 included: Floor A (dirt floor), Floor B (plaster floor), Floor C (stone floor), and Floor D (dirt floor) (Figures 7.22 and 7.23). Above Floor D, we uncovered layers of fill and domestic trash, as well as a burnt layer, possibly roof collapse. These results indicate there were at least five different occupation events in Structure 27. This differs from the rest of the site, where the majority of structures only have one discernable occupation event. These results indicate more time and effort went into remodeling Structure 27, highlighting its importance to the refinery.

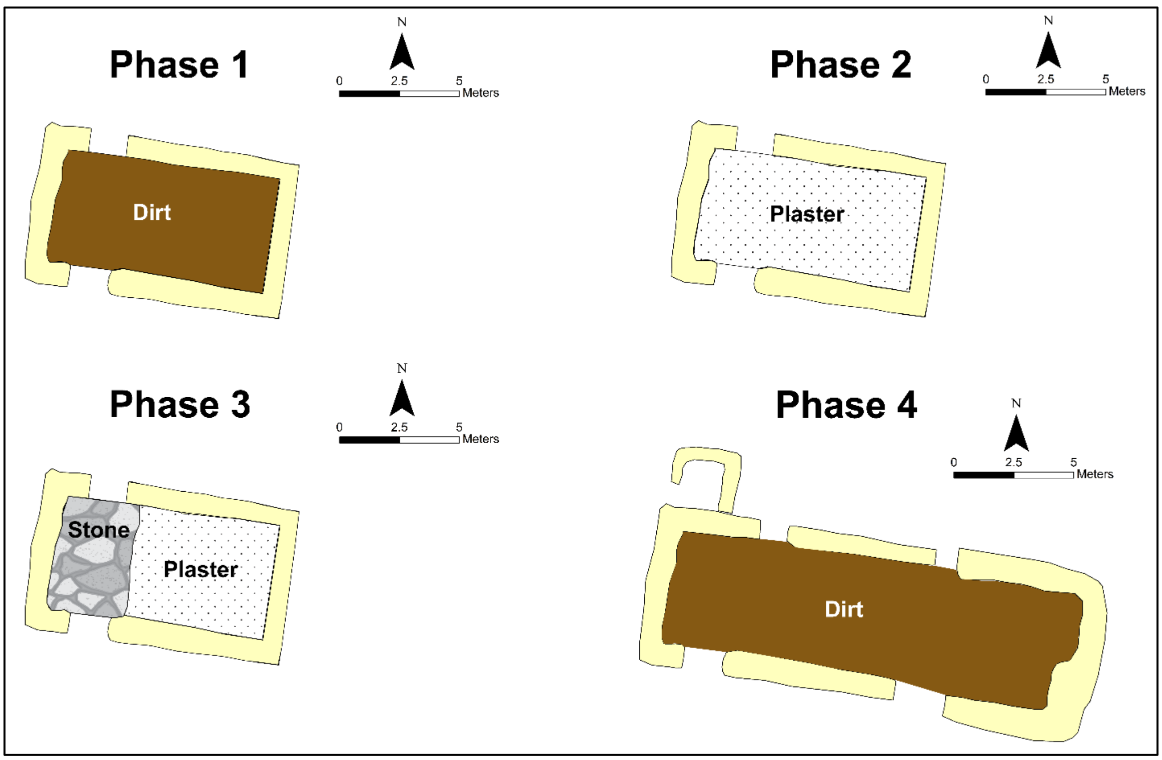

Figure 7.21: The occupation phases of Building 27.

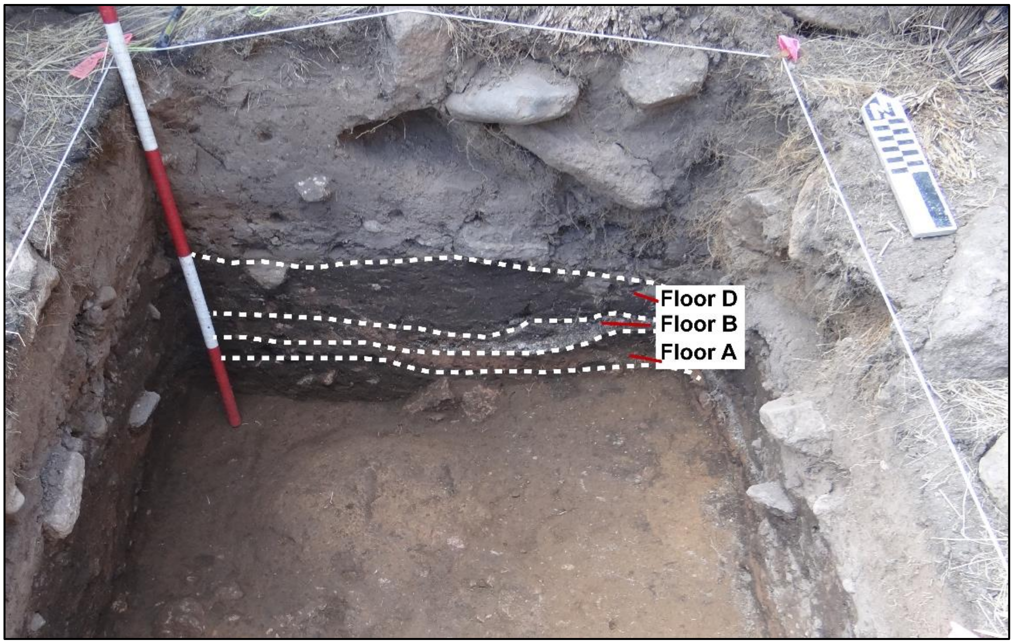

Figure 7.22: Unit 21 excavations. Floor C, the stone floor, is only present in Unit 13.

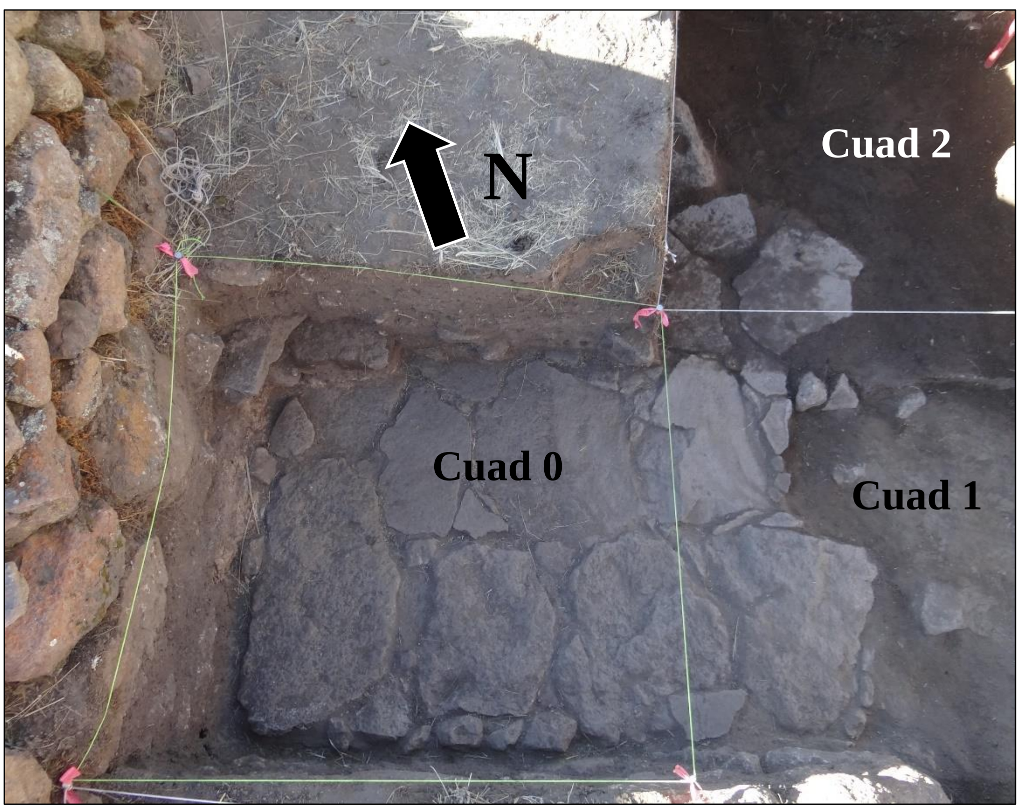

Figure 7.23: Unit 13, with Floor C. The stone floor was only located on the western side of Structure 27.

7.8 Occupation Summary

Occupation and use of the Trapiche refinery appear to have been contained to less than two centuries, sometime between 1650 and 1850 AD (radiocarbon dates are reported in Chapter 8). Most structures at the site had only one occupational floor, likely used throughout the entire site's occupation. This reflects the short and ephemeral nature of silver refinery use, as many refineries were occupied sporadically during wet and dry seasons and were not used for more than a few decades at a time. This also reflects low investment in building remodeling at the site.

Excavations inside Sector C's buildings (Structures 25 and 27) were the only excavations to identify multiple occupation or building events at Trapiche. In Structure 25 (Unit 24), the possible caretaker's house, we identified a large fill event above the living floor, revealing that the building was later used as a trash receptacle. In Structure 27 (Units 13, 20, and 21), we identified the presence of a series of floors and occupation levels, indicating changing use and/or frequent building maintenance over time. Again, these results differed from all other excavation units within structures at Trapiche, which did not have evidence of multiple occupation floors.

Stone floors were only recovered in two locations at Trapiche: Sector A and Sector C (Figure 7.24). It is unclear if these floors represent higher-status, although they do indicate more time investment. They may represent activity areas where a solid, prepared floor was necessary, potentially for metallurgical activities of mixing, heating, or smelting ore. If that is the case, then Unit 11 in Sector A may have first been used to process silver, while being reused at a later date as a domestic structure for cooking and living. However, a stone floor may also have been needed for domestic activities including cooking, to avoid fire danger.

White, lime plaster floors were found in three buildings at Trapiche. The white plaster floors are an important indicator of activity at Trapiche, as the plaster floors would have required more initial effort to build, as well as more effort to maintain over time. The location of plaster floors in the buildings in the eastern section of Sector B indicate this area was used for living quarters, administrative tasks, and other activities not directly related to the manual labor being conducted on the patio below. This suggests higher-status, administrative tasks likely took place above the site, out of reach from the dust and toxic fumes below. These eastern structures all looked directly down on the main patio below, allowing for constant surveillance of labor. Dirt, compacted floors were uncovered in all other structures at the site.

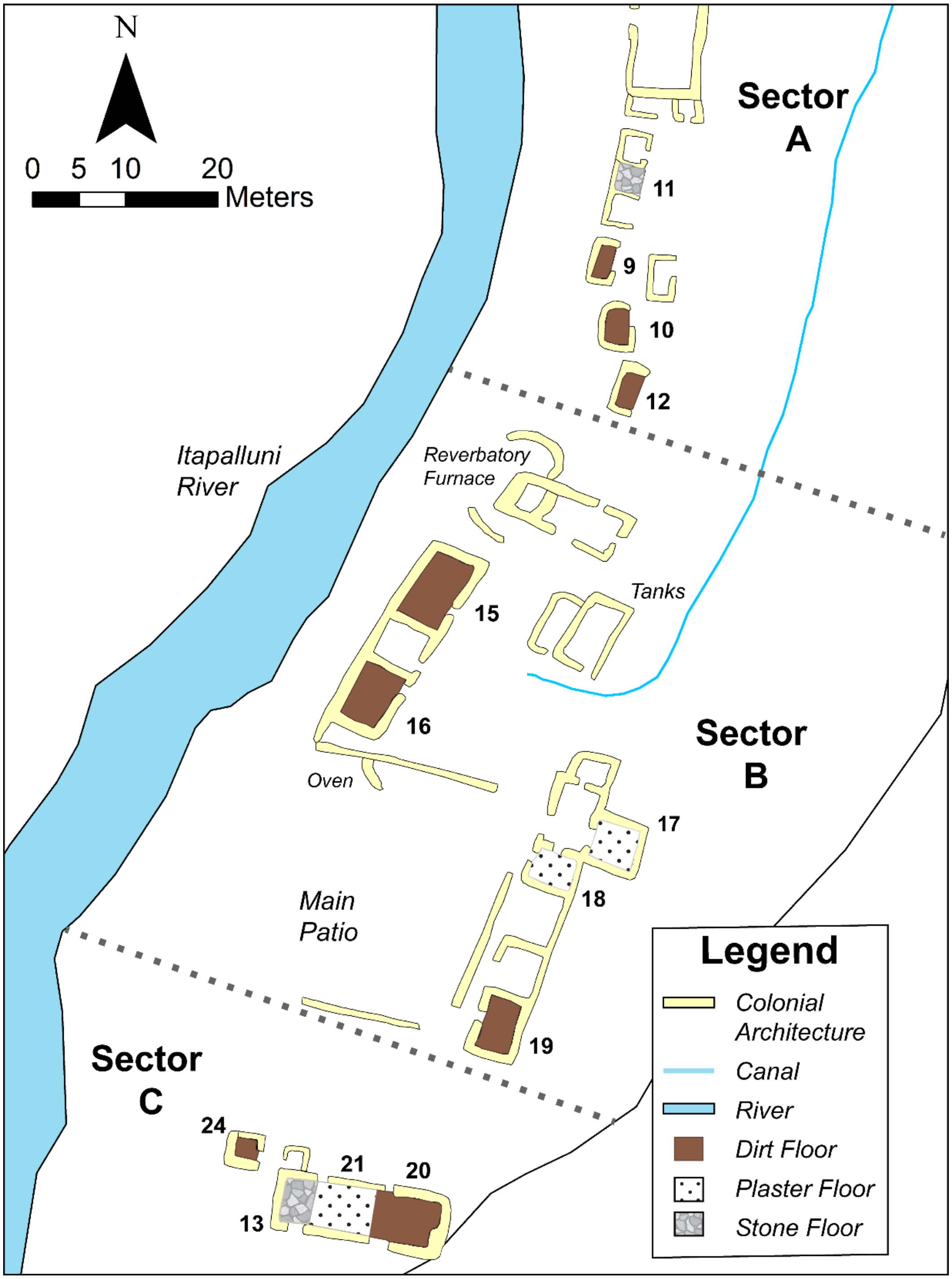

Figure 7.24: Spatial distribution of floor types at Trapiche. The numbers indicate the units of excavation, not the name of the structure.

7.9 Summary

This chapter covered details about the 2018 excavations at Trapiche. It detailed the excavation procedures at the site and discussed various methods used during excavation. Excavation stratigraphy, floors, and architecture were used to determine occupation. Sector C was likely the first area occupied at Trapiche, and Structure 27 may have been an early colonial chapel dating to the early Spanish conquest (mid-16th century). Structure 27 had at least five different occupation events, revealing the changing nature of use at Trapiche. Sectors A and B likely only had 1-2 different occupation events, and/or remolding was not visible in excavations.

Domestic spaces include a hearth in Sector A (Unit 11), a hearth in Sector C (Unit 24) and a communal midden in Sector C. Other domestic areas/living quarters appear to have been in Sector B (Unit 19). Further interpretations about the use of space at Trapiche are detailed in Chapter 9. Detailed information about artifacts from the excavation are detailed in Chapter 8.

The reconstruction of space at Trapiche, as well as refining technology, indicates there were multiple categories of laborers at the site. Unskilled workers were likely used to transport ore to Trapiche, as well as to grind it. However, more skilled refining specialists would have been needed to mix the silver ore with various add-ins, such as mercury, copper, iron, and salt. This knowledge would have been highly prized, and it is unlikely that these specialists participated in the heavy labor of grinding the ore. It is also unlikely they would have been exposed to as much heavy metal poisoning as the unskilled laborers, although they would have needed to oversee much of the work. Their exposure would have likely been through fumes, instead of direct skin contact.

8.0 Artifact Analysis

8.1 Introduction

This chapter presents data from artifact analysis following the 2018 excavations at Trapiche. Included in this chapter are detailed descriptions of each artifact category, as well as descriptions of statistical and other analytical methods used to interpret patterns in said data. Also included are summaries of general data patterns in the following artifact categories: faunal remains; macro-botanicals; lithics; metals; ceramics; special objects; and radiocarbon samples. Following a description of artifact analysis results and basic data trends, a more detailed spatial analysis of trends is detailed in Chapter 9.

8.2 Methodology

8.2.1 **Curation**

Curation and cataloging of excavated materials took place at the Collasuyo Archaeological Research Institute (CARI) field laboratory in Puno, Peru. Collected material was cleaned, cataloged, and inventoried immediately following excavation, from September to December 2018. Following basic curation and inventory, an in-depth analysis of the materials took place during the same time frame. I conducted the analysis of faunal material, lithics, metals, and special objects at the CARI field laboratory in Puno, Peru. Dr. Sarah Kelloway led the ceramic analysis, also completed at CARI. Macro-botanical remains and burnt wood (carbon) were exported to laboratories for analysis and their results and methods will be discussed below.

8.2.2 **Analytical Units**

The artifacts analyzed in this chapter come from surface collection units and excavation units. Surface collection units were located across every sector of Trapiche, including Sectors D and E (where we did not excavate). These collection units have been treated separately from the excavation units because they were not located in the same areas that were eventually determined suitable for excavation. While we may tentatively consider the artifacts from the surface as the "last occupation" of the site, it is important to note that Trapiche sits near a river and a steep cliff, which would have provided 300+ years of post-occupation water, soil, and wind erosion and deposition, altering the location of artifacts across the surface.

The majority of excavation units did not have varied or complex soil stratigraphy and appear to have had one occupation period (see Chapter 7). Artifacts from these units were combined together for the analyses presented in this chapter. This was done for a few reasons. First, a large amount of the deposition in Trapiche units was topsoil and rock wall collapse. While some artifacts were found mixed with the top layers of soil, they were few and did not amount to enough data to consider them separate analytical units. Second, we were able to match some ceramic fragments from lower occupation levels to surface topsoil layers, indicating the surface contexts do not represent later occupation events within these units. Instead, it is likely that a range of disturbance processes affected Trapiche's site formation processes, including freeze-thaw and wind and water erosion.

In Sector C, Unit 24 (Building 25) and Units 13, 20, and 21 (Building 27) did have more than one occupational period. However, we did continue to find matched ceramics from these units in other units across the site, so we proceeded with care when analyzing the artifacts from these locations. Site formation processes would have also affected these units. In many analyzes in this chapter, we continued to combine artifacts from these units and analyze them in one analytical unit. This was especially important with the lithic, faunal, and metal artifacts, as there were not enough materials to make any informative interpretation by separating them out by occupation period. In the ceramic analysis subsection, we provide a more detailed look at change-over-time in these units, but also provide combined analysis to facilitate intra-site comparisons. While combining artifacts from multiple occupation events is problematic, conflating over 100 years of occupation, it did allow for intra-site spatial analysis of Trapiche activities.

8.2.3 **Ceramic Analysis**

All ceramics were washed, catalogued, counted, and weighed at CARI. To determine function and use of pottery, I collaborated with Kelloway to conduct a more in-depth analysis. We recorded all ceramics excavated at Trapiche including non-diagnostics, and recorded individual weight, maximum and minimum width (mm), and maximum and minimum dimension (mm) for each fragment. Further, Kelloway developed a system of paste color and type recording. Kelloway also recorded sherd type, vessel style, vessel form/function, ware type, paste type, construction method, burning, and the use of pigments, glazes, and decorative technique (following Rice 2015).

Counts were used to determine the minimum number of vessels (MNV) at the site. MNV analysis was only carried out on excavated material, although we recorded information on ceramics found on the surface as well to be published at a later date. MNV was calculated by locus, and then across loci within an excavation unit, to check for conjoining sherds. MNV was conducted for all but three units (Units 23, 24, and 25). Time did not allow for a detailed calculation from these units and will occur later. When viewing the ceramic assemblage as a whole, we found that sherd “PAT-068-1” from Unit 14 joined with sherd “PAT-185-1” and sherd “PAT-206-1 from Unit 20 (Figure 8.1). All these fragments are portions of a perforated lid used during mercury reuptake. Unit 20 had very little material and these fragments may have come from the adjacent midden, located in Units 23 and 25 to the west of Unit 20. If they came from the midden, it would be logical for broken pottery to end up here.

Figure 8.1: Lid fragments join to form one vessel. (Left to Right): Locus 168, UE14; Locus 185, Unit 20; Locus 206, Unit 20.

Local vessel style included periods from the 12th century through colonial period. This included the local Late Intermediate Period, local Inka, local Colonial, and imported Colonial. Western Lake Titicaca Basin ceramic styles are well established through regional surveys and excavations for the Late Intermediate (Arkush 2005; de la Vega 1990; Tschopik 1946) and Late Horizon/Inka Periods (Julien 1983; Stanish 1991).

Colonial ceramic chronologies for the Puno region are less established and we combined information from published studies on colonial Andean ceramics (Jamieson 2001; Kelloway 2014; Smit 2018; Tschauner 2001; Weaver 2008, 2015) with excavated materials from Trapiche to develop a reliable colonial chronology. We also relied on the CARI ceramic comparative collection for assigning pastes and styles for the LIP and Late Horizon/Inka periods. Drawings of diagnostic vessels rims appear in Appendix D.

8.2.4 **Botanical Analysis**

Macro-botanical remains recovered during field-screening from 1/4" mesh were bagged during excavation and curated at CARI. Macro-botanicals were placed in vials and tinfoil for protection and were not cleaned.

I conducted the initial analysis of macro-botanical remains recovered from the field at the CARI laboratory using a low-powered stereomicroscope and a handheld digital Dino-Lite microscope. I recorded taxon, material type (seed, coprolite, wood, etc.), portion, and burning, as well as taking measurements of any complete seed. I also had help from paleoethnobotanist colleagues Drs. Katherine Chiou, Alan Farahani, and BrieAnna Langlie. They were extremely helpful with early taxa identification via emailed photographs and helped identify *Capsicum* *baccatum* (chile pepper) and *Prunus persica* (peach) to the species level. All plant remains were identified to the most specific taxa possible during this initial field analysis.

8.2.5 **Faunal Analysis**

I conducted the faunal analysis at CARI and concentrated on species and element identification (Reitz and Wing 2008). To aid in field identifications, I used my personal vertebrate osteological comparative collection stored at the CARI Field House in Puno, as well as numerous identification guides. Faunal remains were identified to the lowest taxonomic level. I recorded specimen count (NISP, or number of identified specimens), element, element portion, symmetry (side), fusion (age), weight, and bone surface modification (weathering, gnawing, burning, butchery). These data were recorded to determine age-at-death, skeletal frequencies, and butchering and consumption patterns.

The minimum number of individuals (MNI) was calculated using fusion, size, and symmetry. Age-at-death was calculated using fusion, dentition, and wear patterns. Categories were split into neonate, juvenile, sub-adult, and adult. Skeletal frequencies were calculated using NISP as opposed to MNI, MNE (minimum number of elements), or MAU (minimum anatomical unit) due to small unit sample size within units of analysis. Skeletal anatomic grouping included: head (skull, mandible, and teeth); axial (ribs and vertebrae); forequarter (scapula, humerus, radius, and ulna); hindquarter (os coxae, sacrum, femur, patella, and tibia); forefoot (carpal and metacarpals); hindfoot (tarsals and metatarsals); and foot (metapodials and phalanges). Butchering practices were recorded and categorized as hacks, saws, and/or cuts. I also recorded evidence of green breaks, marrow extraction, and pot polish. Finally, burning was recorded and categorized into four different degrees of burning: partially black (PB), black (B), black/white (BW), and white (W).

8.2.6 **Soil Sample Collection**

Bulk soil samples were taken during field excavations and sampling strategies entailed blanket sampling to collect a representative sample from a range of contexts (Lennstrom and Hastorf 1995). Systematic soil samples were 10 liters (L). When 10 L of excavated sediment was not available from a context, the entire locus was sampled. Soil samples were processed by Virginia Beatriz Incacoña Huaraya through flotation using a modified SMAP-type mechanized floatation machine (following Watson 1976). Recovery rates are estimated at between 92-96% based on previous poppy seed tests run on the same machine by the same team member (BrieAnna Langlie, personal communication). Light fraction (seeds, charcoal) and heavy fraction (lithics, bones) were collected and bagged separately. Heavy fraction material was screened through a series of graduated sieves (4 mm, 2 mm, 1 mm, and 0.5 mm) at the CARI laboratory and artifacts were extracted and identified by hand.

8.2.7 **Light Fraction**

A total of 119 macro-botanical samples (101 from light fraction, 18 from excavation) were initially sent to the Laboratorio de Palinología y Paleobotánica (the Palynology and Palaeobotanical Laboratory) at the Universidad Peruana Cayetano Heredia (the Cayetano Heredia Peruvian University) in Lima, Peru in December of 2018. There, macro-botanical remains were analyzed by Lic. Fiorella Villanueva using a stereomicroscope (Carl Zeiss, model Stemi DV4, 8-32x magnification), as well as the seed reference collection at the Laboratorio de Palinología y Paleobotánica. Plant structures identified in the samples included stems, seeds, leaves, exocarps, charcoal, inflorescence (flower head of a plant), roots, and fruit. According to the analysis by the

Universidad Cayetano, stems and roots made up most of the light fraction (Figure 8.2). They were unable to identify plant remains beyond the Poaceae (grasses) family level, and individual sample counts, weights, and densities were not determined.

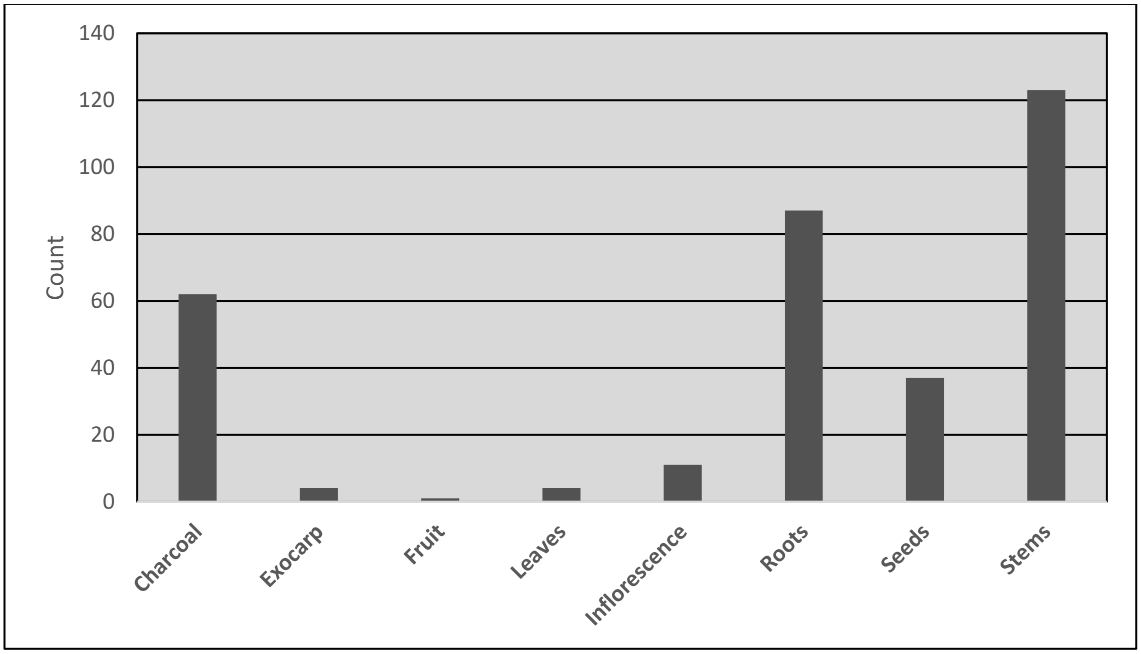

Figure 8.2: Universidad Peruana Cayetano Heredia's analysis of light fraction botanical structures.

Following inconsistencies with the analysis conducted at the Universidad Cayetano, our light fraction samples were spot-checked in June 2019 by paleoethnobotanist Dr. Lizette Muñoz. Muñoz was able to spot-check and re-analyze 50 of the 119 samples. The 50 samples were prioritized because they came from known domestic spaces at Trapiche such as middens, hearths, and occupational floors. Their analysis was important to determine if macro-botanical remains were indeed missed from the prior analysis at the Universidad Cayetano.

While the 50 samples Muñoz spot-checked and analyzed are not a random, representative subsample of Trapiche macro-botanicals, they do present a more detailed picture of plant remains than what was previously analyzed by the Universidad Cayetano. Currently, a full re-analysis of the 119 macrobotanical samples is underway at the Laboratory of Ancient Food and Farming at Binghamton University under the direction of Dr. BrieAnna Langlie. These results will hopefully clarify the picture of macro-botanical use at Trapiche. For the purpose of this dissertation, I will only include the results from the macro-botanical analysis conducted by Muñoz, while acknowledging it is not an entirely representative sample of plant use at the site.

Muñoz conducted her paleoethnobotanical analysis at the Proyecto Arqueológico Haciendas de Nasca laboratory in Palpa, Peru in June 2019. Of the 50 samples she analyzed, 32 came from the light fraction of floated bulk soil samples, while 18 came from the excavation. All samples were hand sorted by Muñoz without need to subsample. Sorting procedure involved separating each sample into similar sized fractions to facilitate analysis (Pearsall 2015). This involved separating each sample into 4 mm, 2 mm, 1 mm, 0.5 mm, and < 0.5 mm fractions, which were weighed and analyzed separately. Due to time constraints, eight 1 mm fraction samples were not 100% analyzed.

Analysis took place using a stereomicroscope (Leica EZ4HD stereoscope, with 10x eyepieces, and an 8x-35x zoom range) following protocols published by Pearsall (2015) and the McCown UC Berkeley Archaeobotany Laboratory. Plant remains were collected in pill capsules and bags. Counts and weights of each botanical taxon were recorded. All seeds greater than 50% complete with their embryos were collected. Genera and species identification were determined by visually comparing ancient plant materials to modern reference collections at the Museo de Historia Natural at the Universidad Nacional Mayor de San Marcos in Lima, Peru, available identification keys, and digital photographic catalogs at the McCown UC Berkeley Archaeobotany Laboratory. Qualitative information, such as preservation, fragmentation, and firing conditions of macro-botanical remains were also recorded (Hubbard and al Azm 1990).

8.2.8 Lithics and Metals

I conducted the lithic and metal analysis at the CARI laboratory using comparative lithic collections already curated and stored at CARI. Ground and chipped stones tools were sorted by form and inventoried. Additional analysis included identification of material and morphology. Metals were analyzed for information on their morphology and manufacture. Specific metal tools, like knives, were analyzed for their functional properties. Other metal objects, such as items of adornment, were evaluated for their composition and function. Metal waste material from the silver refinement process, such as slag, was also recorded, and samples were selected for further export and laboratory XRF analysis.

8.2.9 Other Materials and Special Finds

Other "special" finds, including artifacts made from bone, shell, stone, glass, or other materials, were analyzed to identify their material, morphology, and decoration. They were counted and weighed individually. Guidebooks for colonial artifacts (e.g., Deagan 1987) were consulted to aid in identifications.

8.2.10 **Radiocarbon Samples**

Burnt wood was collected under the category of “carbon” (charcoal) to be used for radiocarbon analyses. These samples were weighed and collected in foil and plastic vials to preserve material. Eighteen radiocarbon samples were initially exported to the United States for analysis, although lack of funding allowed for only six samples to be tested.

Two samples came from each of Trapiche’s three sectors (Sectors A, B, and C) for a total of six samples. Each set of two samples also came from within a specific household, within Units 11, 19, and 21. The samples were chosen from upper and lower cultural levels in each of the households to produce a set of dates related to early and late occupations of each context. Taking samples from each of Trapiche’s three sectors helped establish the earliest and latest occupation events for each sector, facilitating understanding of the use and reuse of the site over time.

Radiocarbon (^{14}C) analyses were conducted at the Penn State Human Paleoecology Isotope Geochemistry Laboratory under the direction of Dr. Brendan Culleton and Dr. Gina Buckley. Charcoal and organic materials were processed for ^{14}C dating using an acid-base-acid (ABA) procedure as described in Kennett et al. (2017). After removing adhering sediment, approximately 20 mg of each sample was subjected to alternating acid-base-acid washes in 1N HCL and 1N NaOH at 70° C for 20 minutes each. The initial acid wash dissolved any carbonate contamination. The repeated base washes extracted humates accumulated from soil organic matter. A final acid wash removed secondary carbonates formed during the base treatment. After this procedure, samples were returned to neutral pH with two 20-minute baths in deionized (DI) water at 70° C to remove chlorides. The samples were then dried.

Samples were combusted for 3 hours at 900°C in vacuum-sealed quartz tubes with CuO powder and Ag wire to produce sample CO_2. Samples were then reduced to graphite at 550° C using H_2 and Fe catalyst, with reaction water drawn off with C-9 Mg $(ClO4)_2$ (Santos et al. 2004). At the Penn State Radiocarbon Laboratory, graphite samples were pressed into targets in A1 cathodes and loaded on a target wheel with standards and backgrounds for AMS analysis. Dates were then calibrated with OxCal v.4.3 (Bronk Ramsey 2013) using the IntCal13 Northern Hemisphere curve (Reimer et al. 2013). Due to the small sample size of one of the samples, one date from Sector A was not processed, leaving only five total dates.

8.3 Statistical Methods

All statistical analyses conducted on artifact assembles at Trapiche were done using the SYSTAT software program (v. 13.2) and Microsoft Excel. Figures were generated through these two programs, although they were often further edited in Adobe Illustrator.

Following the 2017 pilot season, all data were uploaded to an ArcGIS database for further exportation and analysis. To reconstruct spatial patterning across Trapiche, I chose to construct a Geographic Information System (GIS) database that would allow me to integrate a variety of data to view spatially. This included: drone photographs and orthotiff images; digital elevation models (DEMs); UTM coordinates; vector maps of regional rivers and lake systems; the cumulative raster of metallurgical zones created from pXRF soil analysis; and total station data on excavation units and surface artifact scatter. The regional ASTER DEM includes 30 m resolution and was obtained from NASA’s Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) Global Digital Elevation Model.

A site datum was established at Trapiche, which anchored the total station points to the UTM data uploaded to ArcMap. Other reference points from handheld GPS and drone photography were georeferenced in ArcMap to better position the excavation areas to their location in the real world. The database's coordinate system was set to WGS84 (World Geodetic System 1984). Shapefiles were generated in the database based on data from excavation and surface survey, as well as building architecture and pXRF soil data.

8.4 Surface Artifact Assemblage

The surface artifact assemblage was collected in 46 surface collection units across the site, with the majority of artifacts concentrated in Sectors B, C, and D (Figure 8.3). We recorded 747 surface artifacts across Sectors A, B, C, D, and E (Table 8.1). The majority of the surface artifacts were ceramics (n=690, 92% of all surface artifacts), with small amounts of animal bones (n=38), lithics (n=16), and metals (n=3) (Figure 8.4). Sector A only had ceramics, while Sectors B and C had more faunal remains and metals. Sectors D and E had more lithics (Figure 8.5). While we were given permission to collect artifacts from the surface of Sectors D and E, we were not able to excavate in these areas.

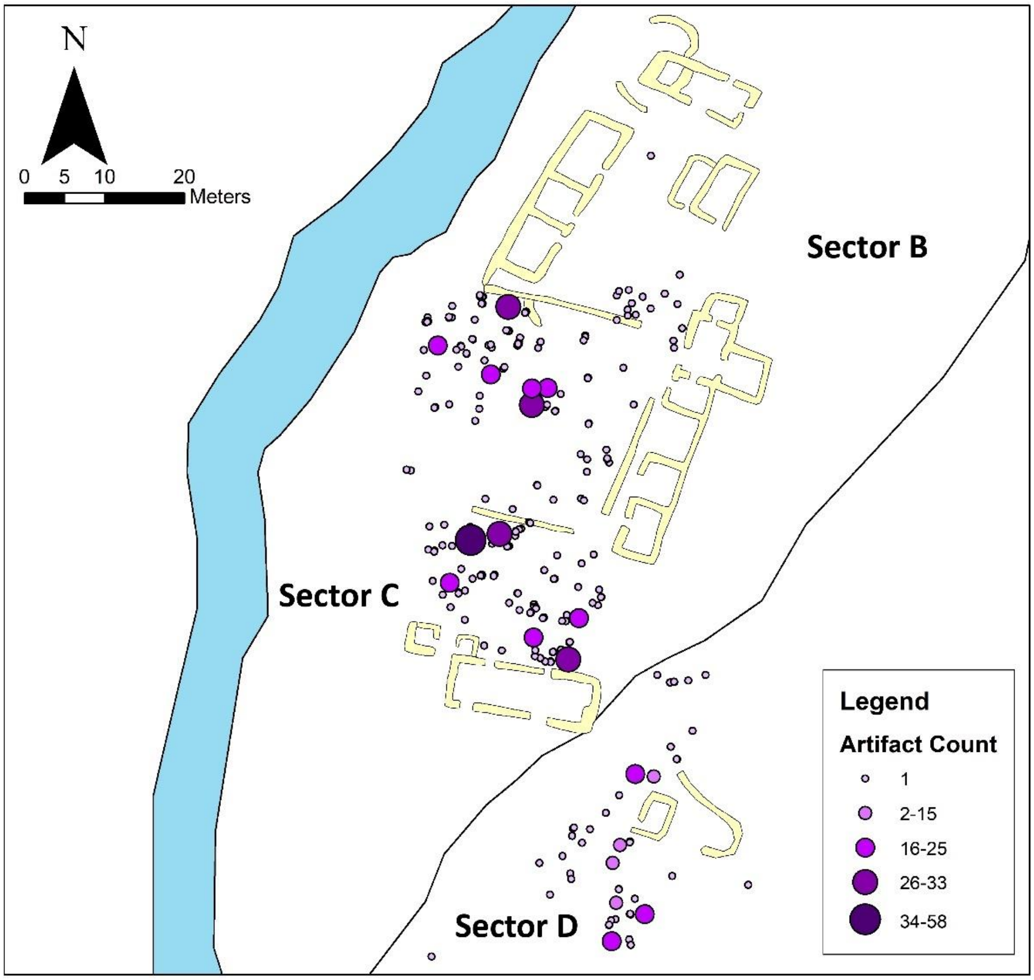

Figure 8.3: Location of surface artifacts mapped at Trapiche, showing concentrations in Sectors B, C, and D.

Table 8.1: Surface Collection Units.

Collection Unit	Sector	Ceramics	Lithics	Metals	Fauna	Total
1	C	32				**32**
2	C	15	1			**16**
3	C	20			12	**32**
4	C	16				**16**
5	C	21				**21**
6	C	31				**31**
7	C	17		1	3	**21**
8	C	12				**12**
9	C	20	1			**21**
10	C	7	1			**8**
11	C	14				**14**
12	C	9				**9**
13	B	24	1			**25**
14	B	6				**6**
15	B	23				**23**
16	B	29	1			**30**
17	B	22				**22**
18	B	24			7	**31**
19	B	19				**19**
20	B	21		1		**22**
21	B	15				**15**
22	B	17				**17**
23	B	22	1		5	**28**
24	B	19			10	**29**
25	B	13		1		**14**
26	B	14				**14**
27	A	8				**8**
28	A	4				**4**
29	A	16				**16**
30	A	2				**2**
31	A	4				**4**
32	D	14				**14**
33	D	10				**10**
34	D	20	1			**21**
35	D	7				**7**
36	D	17				**17**
37	D	11				**11**
38	D	21	3		1	**25**
39	D	19	3			**22**
40	D	12				**12**
41	D	13				**13**
42	D		1			**1**
44	D	7				**7**
45	E	1	2			**3**
46	E	22				**22**
Grand Total		**690**	**16**	**3**	**38**	**747**

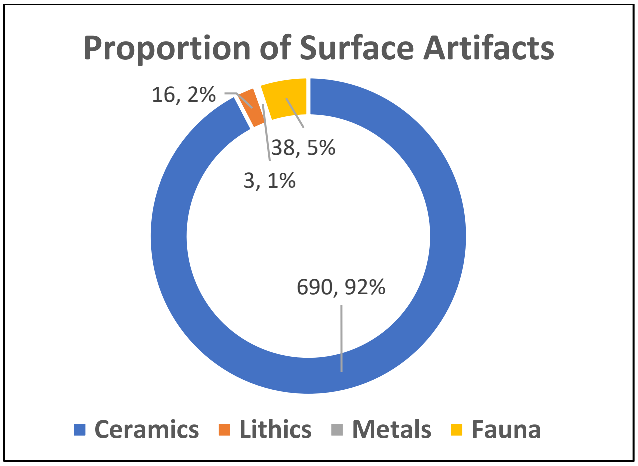

Figure 8.4: Percentage of artifact types found on the surface of Trapiche.

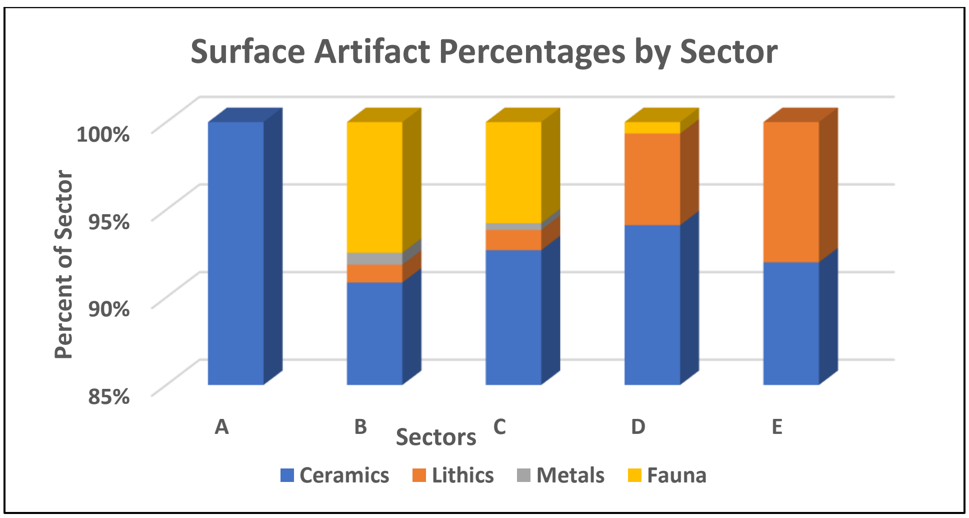

Figure 8.5: Percentage of surface artifact types by sector.

None of the faunal remains recovered from the surface were able to be identified past the general Mammalia (mammal) category, as they were too weathered and fragmented to determine species or element. They did cluster near the midden in Sector C (later excavated in Units 23 and 25), as well as near the mercury oven in Sector B (later Unit 8).

Metal objects (n=3) only occurred in Sectors B and C. Collection Unit 25 had a nail, and was placed near the administrative buildings on the east side of the main plaza in Sector B. We also found two scraps of copper in Sector C, near the midden. Lithic artifacts occurred in all five sectors (Figure 8.6). There was more diversity of lithic types in Sectors A, B, and C, while Sectors D and E only contained flakes.

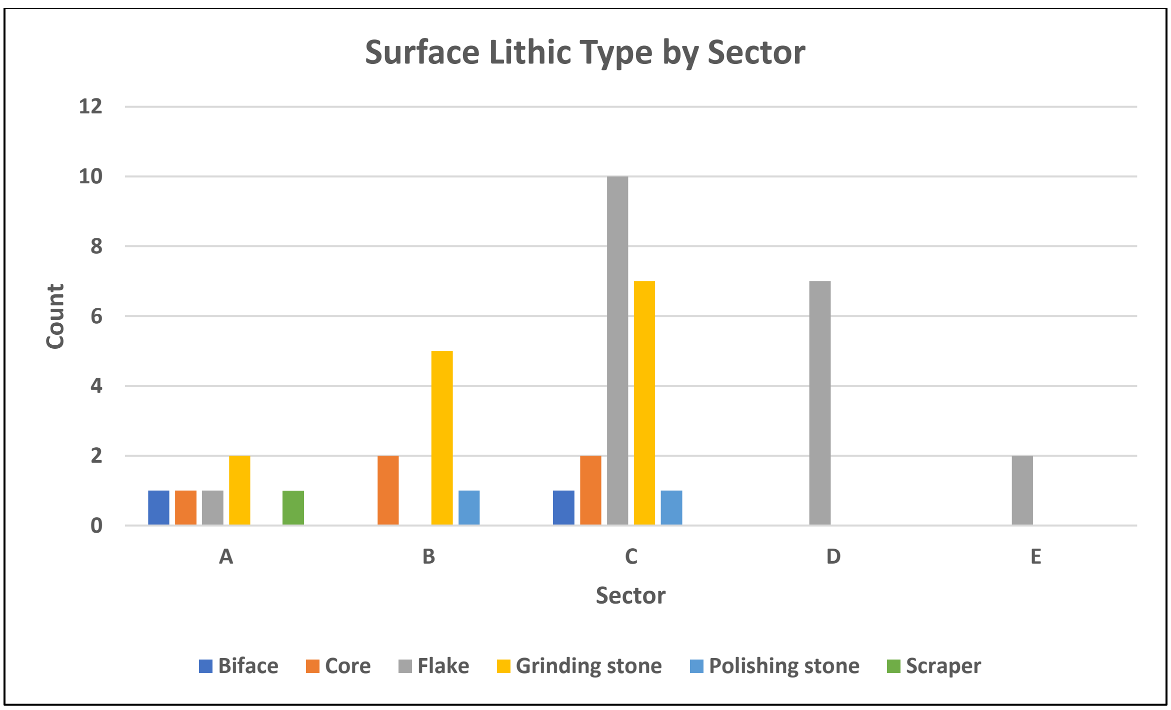

Figure 8.6: Surface lithics distributed by type across the site sectors.

The majority of artifacts collected from the surface of Trapiche were ceramics, found in every sector of the site. The majority of surface ceramics were local in style (n=87, 57% of surface ceramics), followed by colonial (n=61, 40%) and fine ware ceramics that resemble Inka style pottery, but may be colonial interpretations (we are calling it “Inka-like”) (n=5, 3%) (Figure 8.7). Sector A, hypothesized as the location of indigenous laborers, had only local-style pottery. In contrast, Sectors B and C had a large number of colonial-style ceramics (40%). Interestingly, Sectors D and E were the only two sectors to have the Inka-like ceramics recorded on their surfaces. It is unclear if this indicates these areas represent some type of ethnic or status identity linked to fine ware/Inka imitation ceramics.

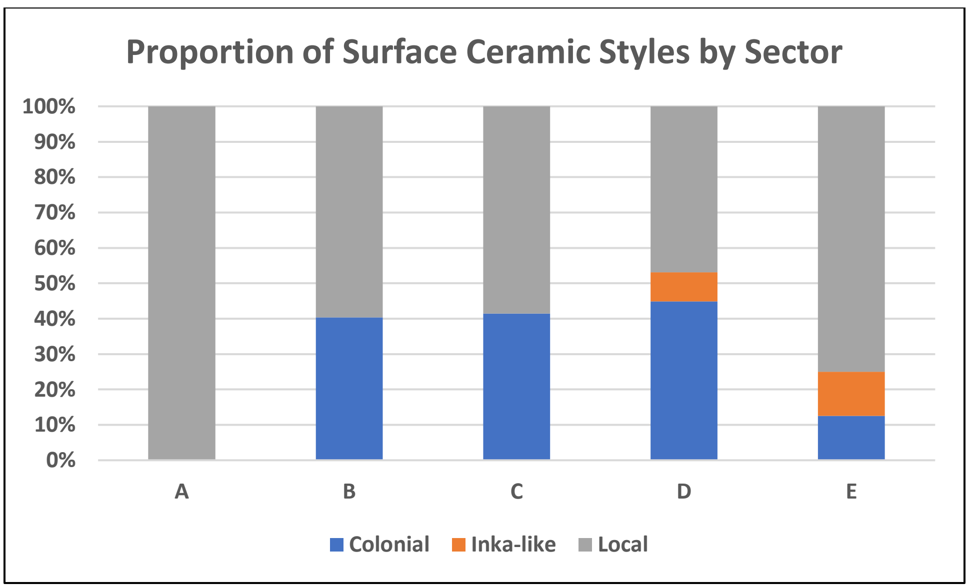

Figure 8.7: Percentage of surface ceramic styles by sector.

Surface ceramics were also analyzed by ware (Figure 8.8). The majority of surface ceramics at Trapiche were unglazed, coarse redwares, and these ceramics make up at least 40% of each sector's total ware count. We only found unglazed coarse ware in Sector A, and this aligns to the "local" style of ceramic production. The other four sectors include a mix of ceramic wares. Spanish olive jars, or *botijas*, were found in Sectors B, C, D, and E, although the majority came from Sector D (n=28). *Botijas* were used for storage and shipping containers, containing commodities like olive oil, wine, and honey, as well as necessities like potable water. The large amount of *botijas* in Sector D indicates this area may have been a storage area for goods transported into the site, or it may have been an area to regulate the import and export of goods.

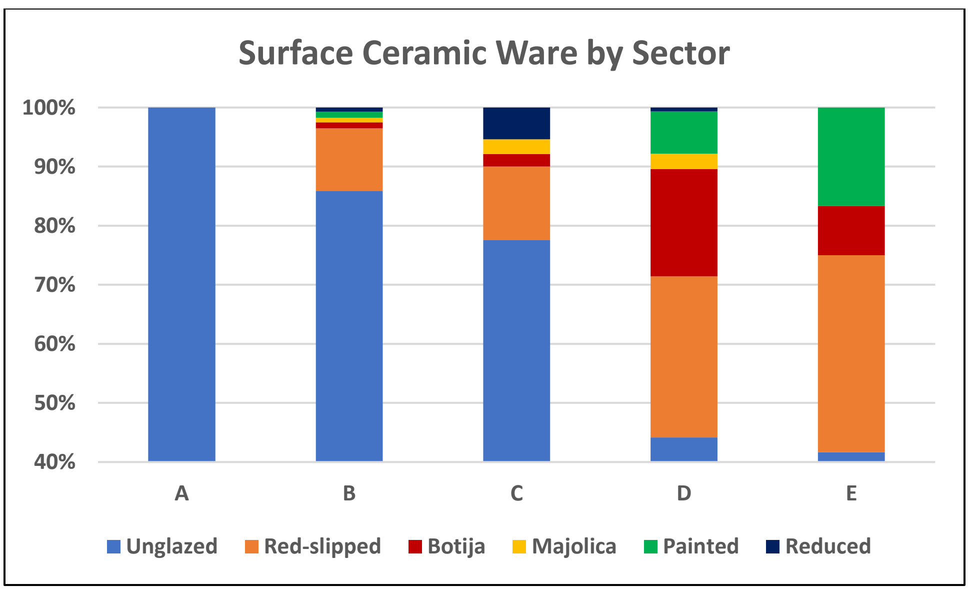

Figure 8.8: Surface ceramic wares by Sector.

Finally, we analyzed the surface ceramics found at Trapiche by their function (Figure 8.9). While many of the surface ceramics were small and fragmented, we were able to determine differences in three categories of function: serving, storage, and transport/storage. Only two ceramics found in Sector A were large enough to determine their function, which was storage. The site core of Trapiche (Sectors A, B, and C) had a majority of storage ceramics in their surface assemblages, in contrast to Sectors D and E, which had a majority of serving wares. Because we were not able to excavate in Sectors D and E, it is difficult to say whether these sectors represent domestic households, given their large amount of serving wares. We did not identify any large *ollas* or cooking vessels in any the surface artifact collection.

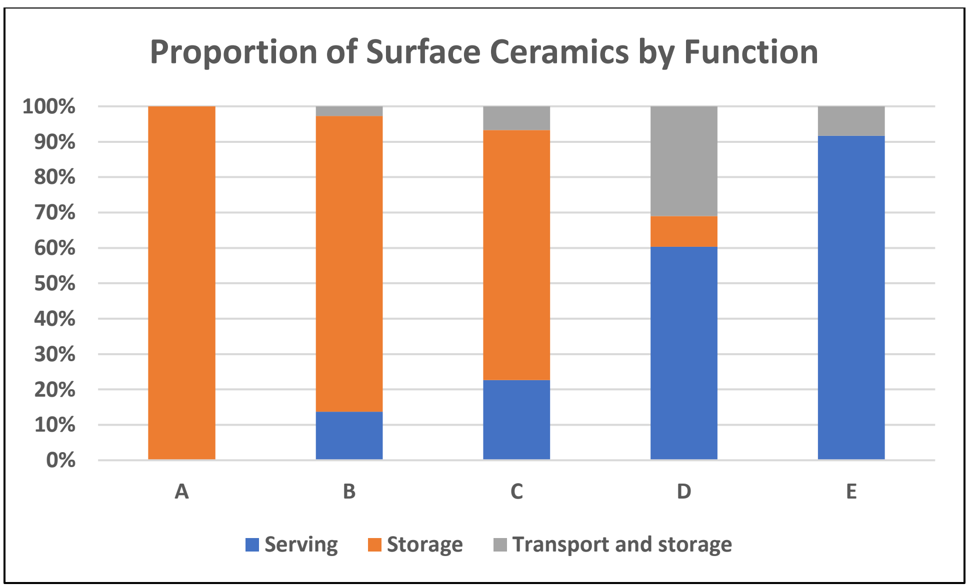

Figure 8.9: Surface ceramics by function across sectors.

8.5 The Excavated Assemblage

The excavated assemblage is dominated by ceramic remains (n=3025, 67% of total artifacts recorded). Faunal (animal) remains are the second most prevalent material class by count (n=1485, 27% of total excavated artifacts). The remaining five material classes (lithics, metals, carbon, others, and botanicals) make up 8% of the total count of materials (Figure 8.10).

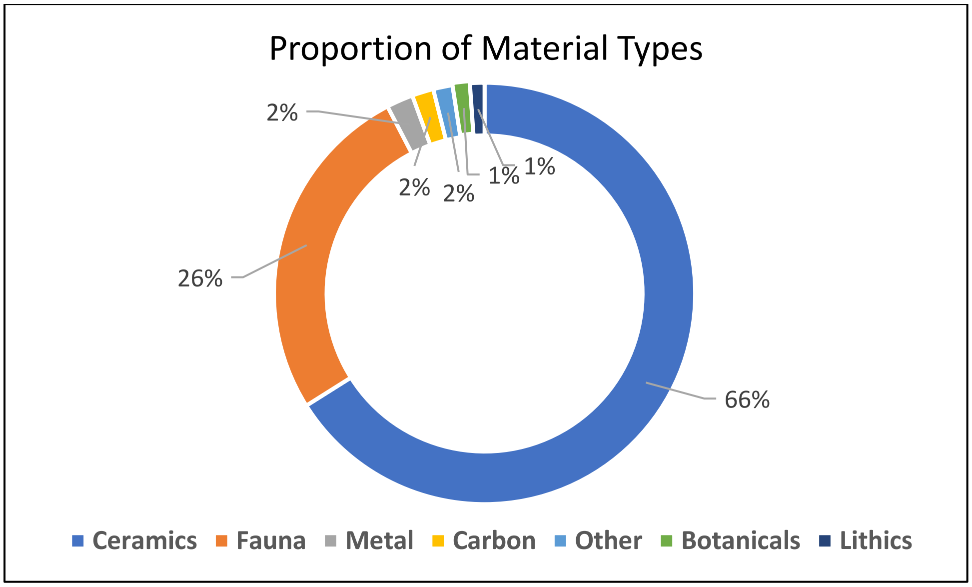

Figure 8.10: Percentages of excavated material types for Trapiche.

The percentage of material types at Trapiche indicate the importance of storage, material transport, and provisioning for the site. Ceramic vessels, such as *botija* olive jars, were used to store and transport food, water, and supplies, and mercury pots were used to transport and recover mercury, which was a valuable material during the refining process. A more in-depth discussion of ceramic results can be found in a subsequent section of this chapter below. The overall number of lithic artifacts is low (n=51) compared to that of ceramics (n=3025), fauna (n=1485), and other artifact categories (Figure 8.11).

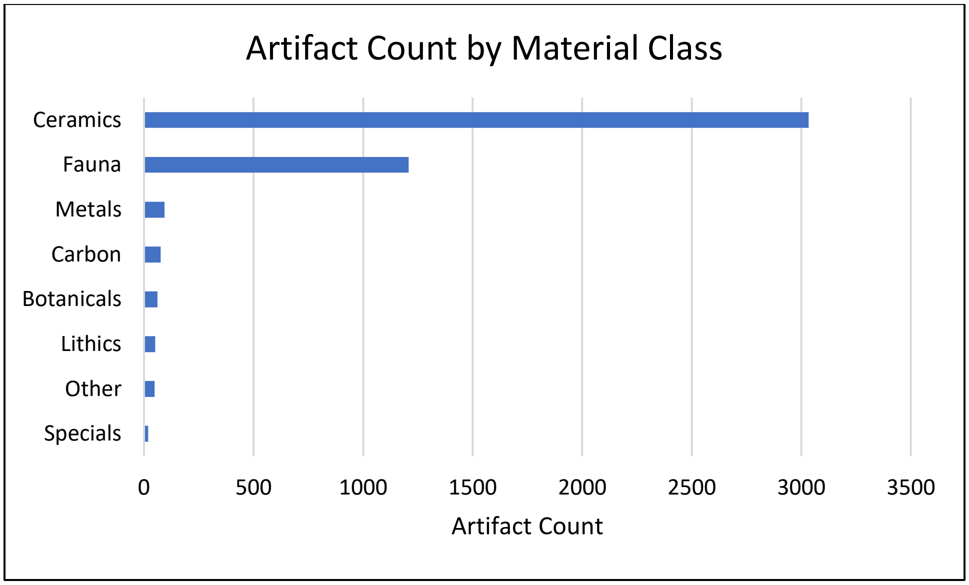

Figure 8.11: Total count of excavated artifacts by material class.

8.6 Faunal and Botanical Results

8.6.1 Faunal Results

NISP, MNI, and weight are recorded in Table 8.2. In total, we recovered 1,485 vertebrate specimens, with a total MNI of 48 individuals and a total weight of 2,534.86 g. Specimens were identified to 25 different vertebrate categories. The assemblage is dominated by mammal remains, making up 99% of the total identified taxa list (Figure 8.12). Taxa refers to taxonomic categories of variable specificity – for example, family, genus, or species.

Mammal taxa identified at Trapiche include a mix of native Andean species such as camelid (Camelidae) and guinea pig (*Cavia porcellus*) (NISP=51), as well as Eurasian domesticates such as sheep/goats (Caprinae), pig (*Sus scrofa*), cattle (*Bos taurus*), and horse/donkey (Equidae) (NISP=71) (Figure 8.13). Overall, the assemblage was dominated by camelids (NISP=47; MNI=14) and sheep/goats (NISP=40; MNI=4). Birds included domestic chicken (*Gallus gallus*) (NISP=2) and others (NISP=9), likely local waterfowl. Fish taxa include native lake fish (*Orestias sp.*) (NISP=1) and marine fish (Perciformes) (NISP=1). Figures 8.14 – 8.16 show NISP, MNI, and weight of major animal taxa groups at Trapiche.

Table 8.2: NISP, MNI, and Weight of Vertebrate Fauna.

Taxon	Common Name	NISP	%	MNI	%	Weight (g)	%
Rodentia	Rodents	10	0.67	3	6.25	1.07	0.04
Cavia porcellus	Guinea pig	2	0.13	2	4.17	0.36	0.01
Canidae	Canines	1	0.07	1	2.08	0.27	0.01
Equidae	Horse/donkey	10	0.67	4	8.33	214.78	8.47
Artiodactyla or Perissodactyla	Even- or odd-toed ungulates	7	0.47	1	2.08	2.79	0.11
Artiodactyla	Even-toed ungulates	140	9.43	14	29.17	203.72	8.04
Sus scrofa	Pig	3	0.20	2	4.17	13.55	0.53
Camelidae	Camelids	47	3.16	14	29.17	604.68	23.85
Bos taurus	Cow	13	0.88	4	8.33	292.43	11.54
Bos taurus or Equidae	Cow or horse/donkey	5	0.34	1	2.08	182.82	7.21
Caprinae	Sheep/goat	40	2.69	4	8.33	166.6	6.57
Small Mammal uid[16]	UID small mammal	23	1.55	-	-	1.42	0.06
Medium Mammal uid	UID medium mammal	30	2.02	-	-	13.98	0.55
Large Mammal uid	UID large mammal	211	14.21	-	-	505.25	19.93
Mammal uid	UID mammal	927	62.42	-	-	300.04	11.84
Total Mammalia		**1469**	**98.92**	**44**	**91.67**	**2503.76**	**98.77**
Galliformes or Anseriformes	Goose or chicken	1	0.07	1	2.08	0.29	0.01
Gallus gallus	Chicken	1	0.07	1	2.08	1.91	0.08
Small Aves uid	UID small bird	2	0.13	-	-	0.81	0.03
Medium Aves uid	UID medium bird	5	0.34	-	-	1.74	0.07
Large Aves uid	UID large bird	1	0.07	-	-	0.91	0.04
Aves uid	UID bird	1	0.07	-	-	0.11	0.00
Total Aves		**11**	**0.74**	**2**	**4.17**	**5.77**	**0.23**
Orestias sp.	Andean pupfish	1	0.07	1	2.08	0.00	0.00
Perciformes	Ray-finned fish	1	0.07	1	2.08	0.65	0.03
Actinopterygii-large	UID large bony fish	2	0.13	-	-	11.02	0.43
Actinopterygii uid	UID bony fish	1	0.07	-	-	0.01	0.00
Total Actinopterygii		**5**	**0.34**	**2**	**4.17**	**11.68**	**0.46**
Vertebrata[17]						13.65	0.54
Sample Total		**1485**	**100.00**	**48**	**100.00**	**2534.86**	**100.00**

[16] UID/uid = unidentified
[17] Unidentified remains were recorded as vertebrata and were collectively weighted without being counted.

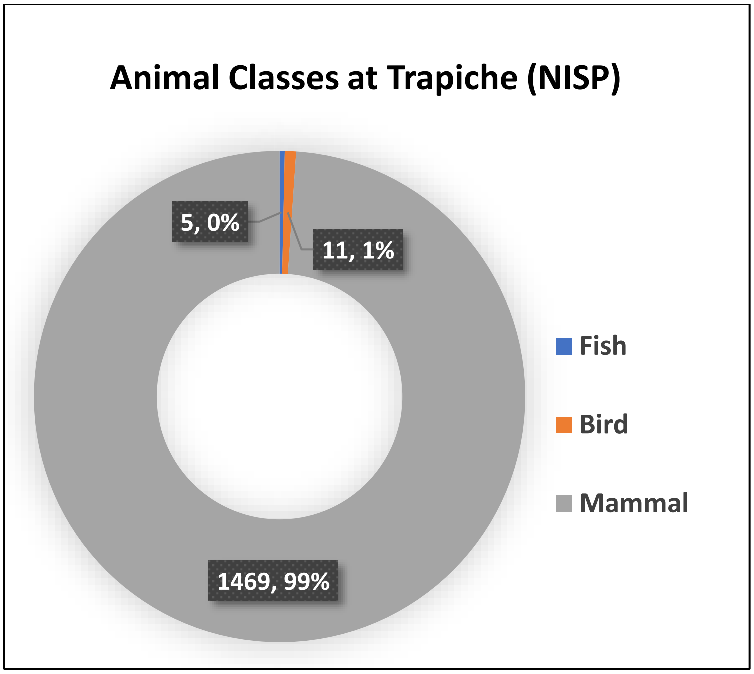

Figure 8.12: Percentage of animal classes in excavated remains.

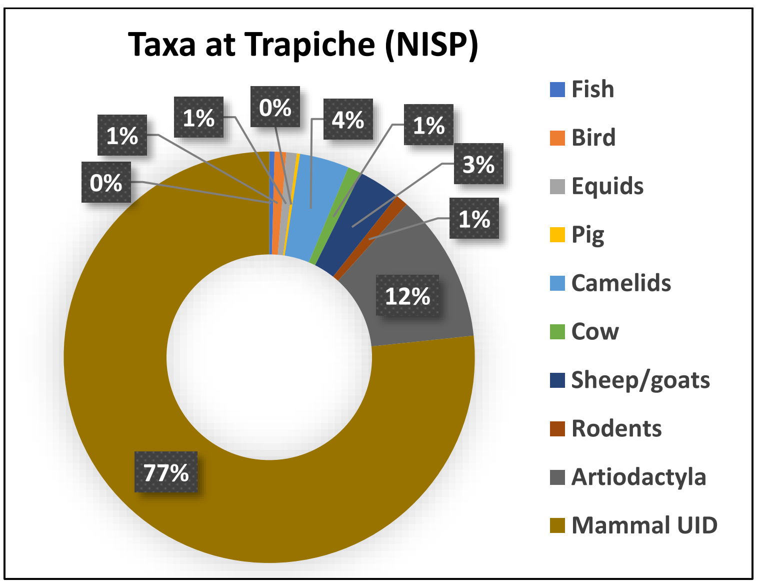

Figure 8.13: Proportion of animal taxa excavated at Trapiche.

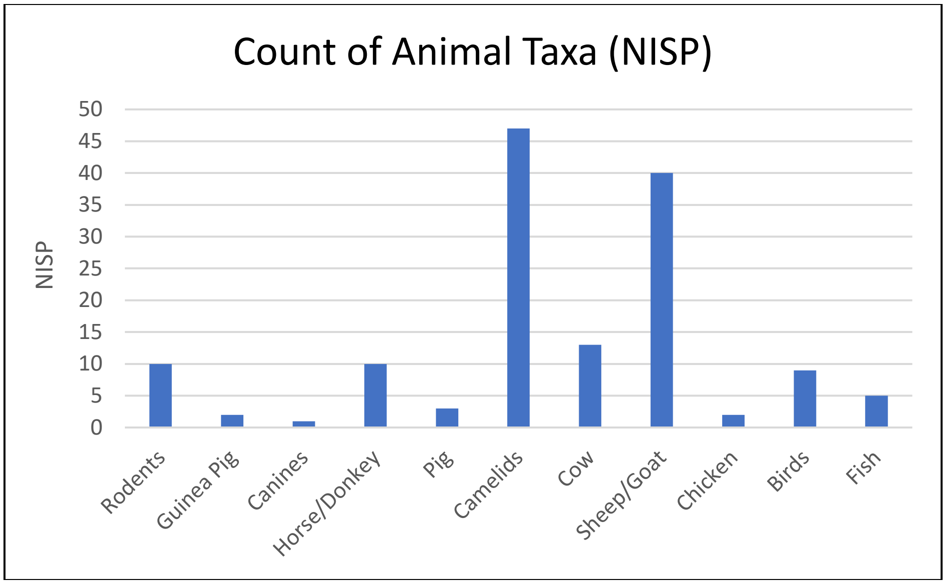

Figure 8.14: Count of animal taxa (NISP).

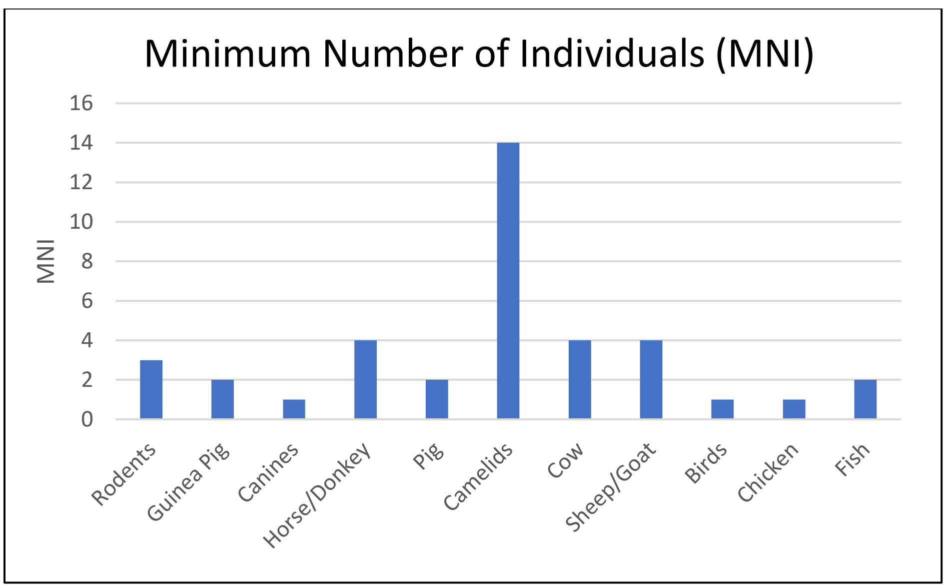

Figure 8.15: Minimum number of individual taxa (MNI).

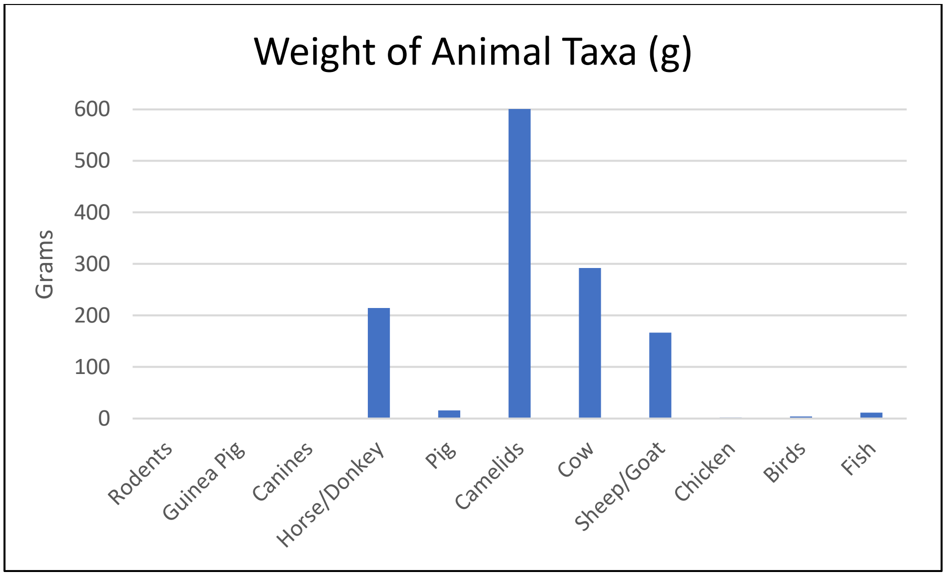

Figure 8.16: Weight of animal taxa (grams).

A closer look at intra-site patterns of faunal remains reveals that Sector C has the greatest taxonomic richness of animal species, while Sector A had the least taxonomic richness (Table 8.3). Further chi-square analyses reveal very significant and strong differences of animal taxa proportions between Sectors A, B, and C ($\chi^2 = 58.9$, $df = 22$, $p < 0.001$, *Cramer's V*=0.324).

Table 8.3: Presence of Animals by Sector.

Animal	Sector A	Sector B	Sector C
Rodents		x	**X**[18]
Guinea Pig		x	x
Canines			x
Horse/Donkey	**X**		**X**
Artiodactyls	**X**	**X**	**X**
Pig			x
Camelids	x	**X**	**X**
Cow		x	**X**
Sheep/Goat		**X**	**X**
Chicken			x
Fish			**X**

[18] **X** = great than 5 specimens; x= less than 5 specimens.

These results correspond to the location of the principal communal midden at Trapiche, which was in Sector C. Remains from Sector A and B come from living floors and residential hearths. Camelids and artiodactyls are present in all three sectors. Eurasian domesticates appear to slightly outnumber Andean fauna in each sector (Figures 8.17 and 8.18).

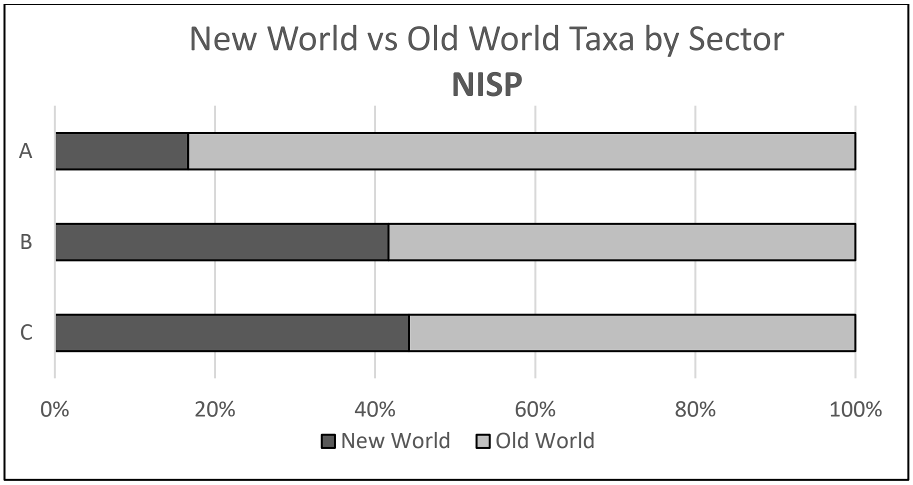

Figure 8.17: Proportions of New and Old World fauna by sector, using NISP.

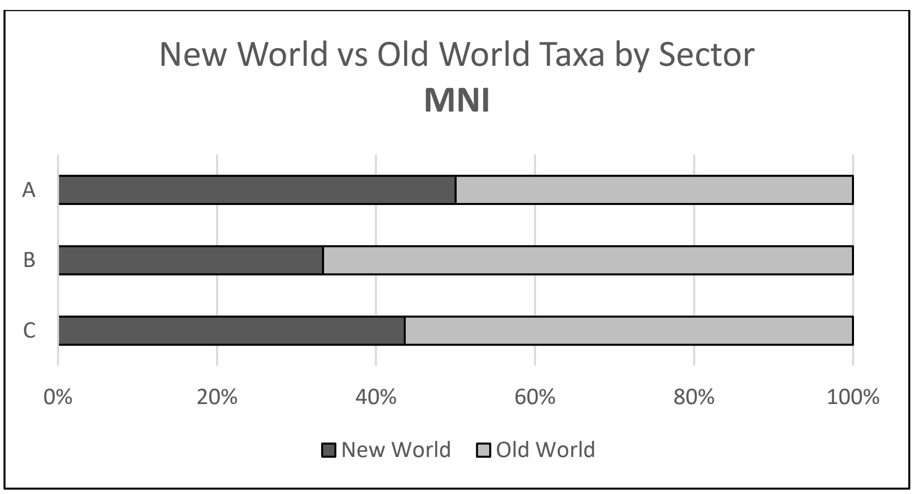

Figure 8.18: Proportion of New and Old World faunal by sector, using MNI.

A more in-depth look at faunal variation by unit is presented in Table 8.4. Laborer households have lower faunal species richness (3 taxa) than the overseer/owner house (8 taxa). The communal midden, chapel, and caretaker house have the highest number of species richness (17 taxa).

Age profiles for fauna at Trapiche were only calculated for camelids and sheep/goats, as these species had high enough specimen counts to calculate accurate age profiles (Figure 8.19). The majority of camelids and sheep/goat remains came from adult individuals above 1.5 years of age, with developed dentition and fused epiphyses. Based on dentition wear, adult camelid remains were most frequently determined to be between 2 and 2.5 years of age. Sub-adult and juvenile remains were quite rare, and the assemblage is characterized by older adult animals.

Table 8.4: Fauna NISP and Precent Frequency Across All Units.

Sector	UE	Context	Rodentia	Cavia porcellus	Canidae	Equidae	Artiodactyl/Perissodactl	Artiodactyla	Sus scrofa	Camelidae	Bos taurus	Bos taurus or Equidae	Caprinae	UID Mammalia	Galliform/Anseriform	Gallus gallus	UID Aves	Orestias sp.	Perciformes	UID Actinopterygii	TOTAL
A	4	Patio						8													8
A	9	Laborer												10							10
A	10	Laborer								1				13							14
A	11	Laborer												73							73
A	-	Mill wall				5															5
B	6	Work Patio											2	2							4
B	8	Oven						1						16							17
B	14	Industrial						1			2		1	26			1				31
B	15	Admin								3			1	4							8
B	16	Admin						1					1	5							7
B	17	Admin								1		1	1	6							9
B	18	Admin						2						14							16
B	19	High Status	4	1				14		5		1	3	62			2				92
B	-	Looter Pit								2			1	29							32
C	13	Multi-purpose						4		4	2		2	62			1				75
C	20	Multi-purpose												2							2
C	21	Multi-purpose	4			2		15	1	3	2	1	10	213					1	2	254
C	23	Midden	2	1		1		51	2	19		1	14	370	1		2			1	465
C	24	House/storage						10		3	7	1	4	155		1	3	1			185
C	25	Midden			1	2	7	33		6				129							178
		Total Count	**10**	**2**	**1**	**10**	**7**	**140**	**3**	**47**	**13**	**5**	**40**	**1191**	**1**	**1**	**9**	**1**	**1**	**3**	**1485**
		Percent Frequency	**0.67**	**0.13**	**0.07**	**0.67**	**0.47**	**9.43**	**0.20**	**3.16**	**0.88**	**0.34**	**2.69**	**80.20**	**0.07**	**0.07**	**0.61**	**0.07**	**0.07**	**0.20**	**100**

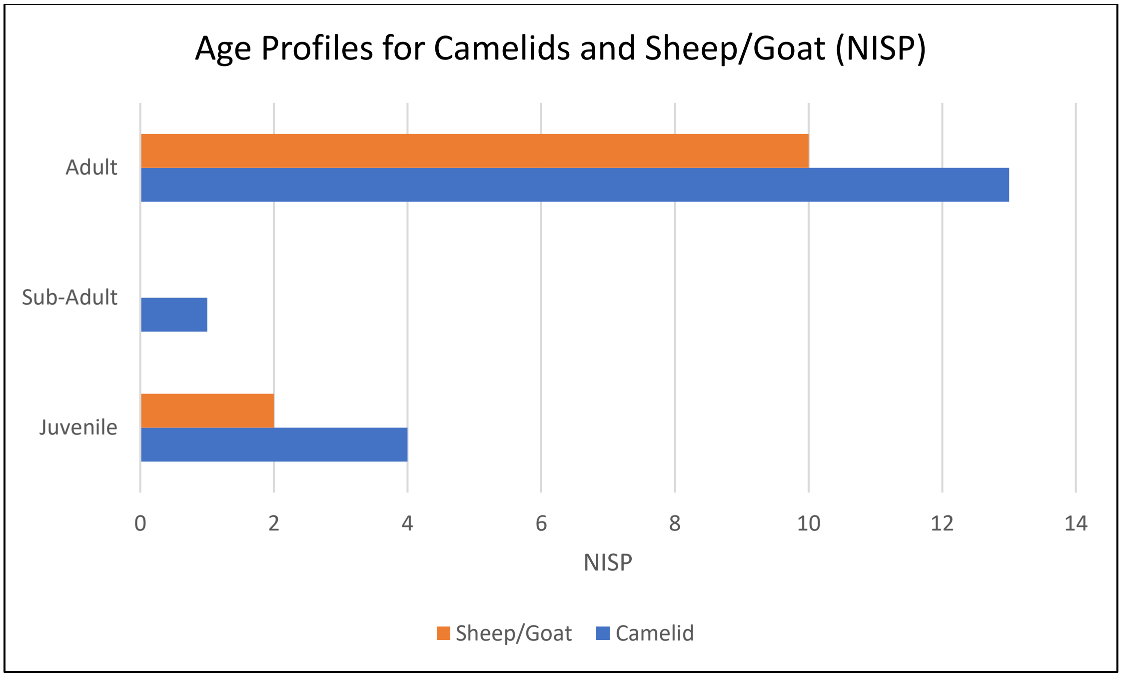

Figure 8.19: Age profiles for camelids and sheep/goats.

Skeletal frequencies for fauna at Trapiche were calculated for large domestic mammals, including camelids, sheep/goats, and cows/equids (Figure 8.20). Pig remains were not included because of their small number of specimens (NISP=3). Horse and cow remains were combined as many elements were determines to be either horse *or* cow, due to their large size, but further taxonomic determinations were not possible. NISP was used for calculation instead of MAU (minimum anatomical unit) due to the small sample size.

One of the major skeletal trends that stands out is the large amount of forequarter elements (scapula, humerus, ulna, and radius) from camelids at the site (Figure 8.21). There was a total of 15 forequarter units (37.5% of all camelid remains), with many of those identified as humeri and radius-ulnas. These findings indicate specific meat cuts purchased from market environments. Another trend in the data is the large amount of foot elements among sheep and goats (including metapodials and phalanges). This accounts for 27.5% (NISP=11) of all sheep and goat elements found at the site. It is possible sheep and goats were butchered onsite, or that low-quality cuts of mutton were eaten by Trapiche residents.

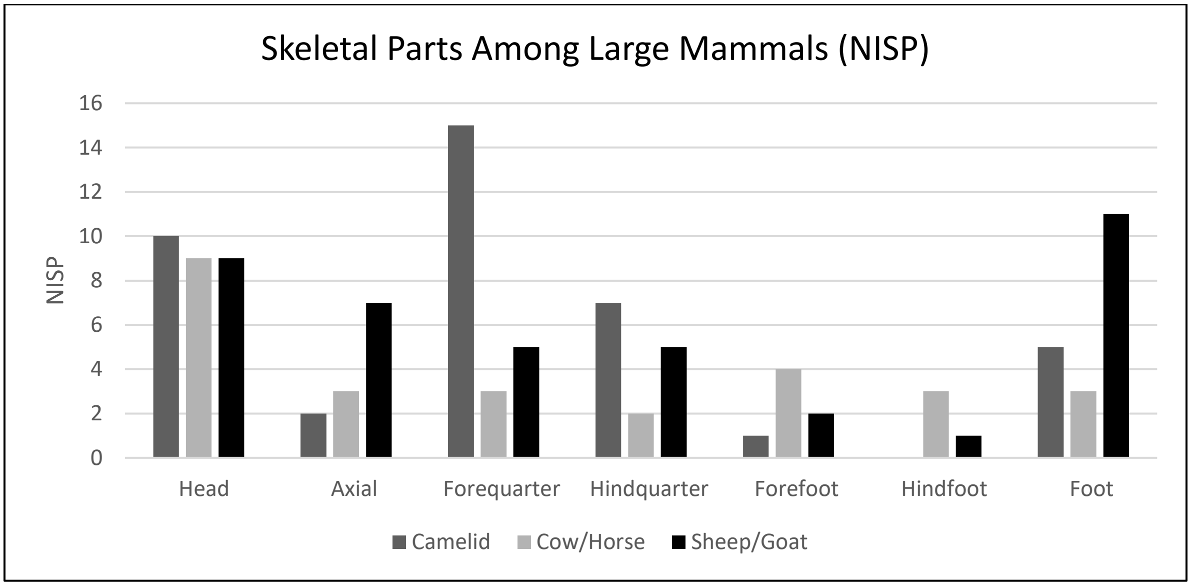

Figure 8.20: Skeletal parts of large mammals (NISP).

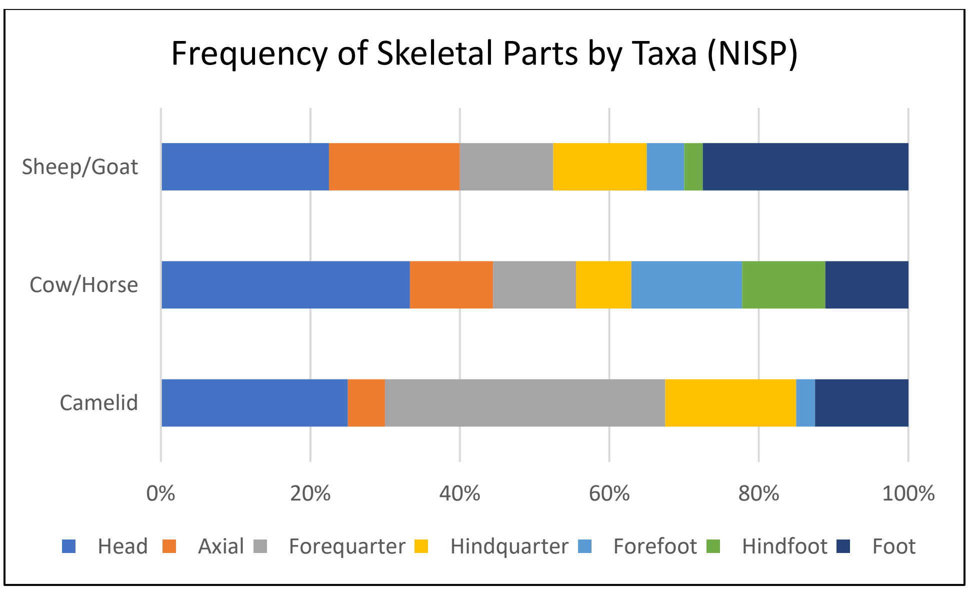

Figure 8.21: Frequency of skeletal parts of large mammals (NISP).

Bone modifications present at Trapiche included burning and butchering. Roughly one-third (30.9%) of all faunal material recovered from the site was burned and burning was present in 75% (15 of 20) of all contexts. The majority of the burned remains were black or black-white, indicating relatively high levels of heat (Figure 8.22, Table 8.5). The highest frequency of burnt bones occurred in Sector C, in Units 23 (7.9% of total assemblage) and 24 (6.5% of total assemblage). Unit 23 was placed in the midden, so burning here suggests both food processing (roasting) and later trash disposal activities. Unit 24 was placed inside the residence adjacent to the chapel, and contained a hearth, as well as a later burned trash fill. In order to determine the specific function of the burning in Unit 24 (i.e., for cooking or for disposal), a more detailed analysis of internal bone structure is needed.

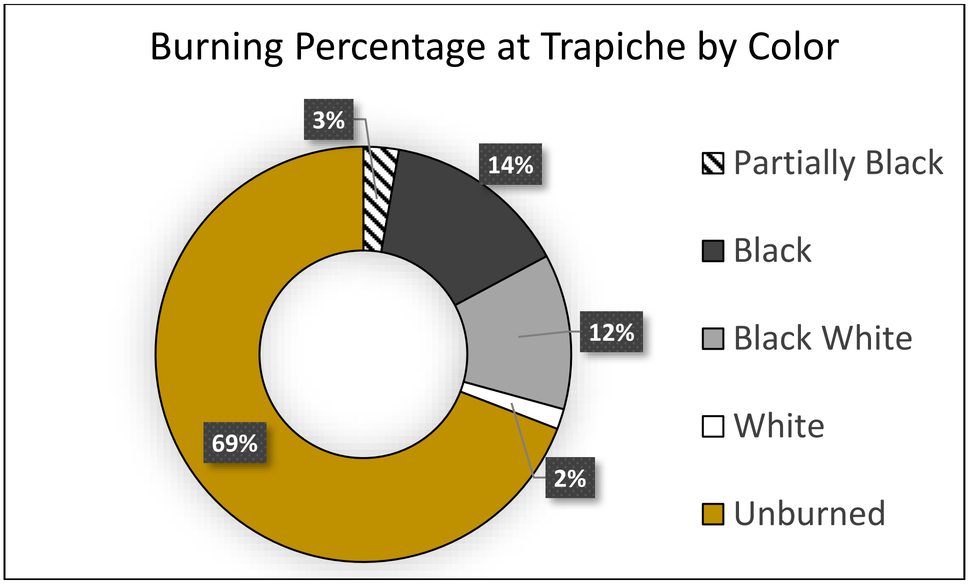

Figure 8.22: Percentage of burned bones.

Table 8.5: Count of Burnt Bones by Unit (NISP).

UE	6	8	9	11	13	14	15	16	17	18	19	21	23	24	25	Total	%
Partially Black		3			8	4				1		12	25	5	1	**59**	**8.9**
Black	2	6	1	48	4	22	8	5	5	1	8	29	61	87	24	**311**	**46.9**
Black/ White		7	7	13		25				4	27	13	73	40	50	**259**	**39.1**
White			1			5						7	10	7	4	**34**	**5.1**
Total	**2**	**16**	**9**	**61**	**12**	**56**	**8**	**5**	**5**	**6**	**35**	**61**	**169**	**139**	**79**	**663**	**100**

Butchering was observed on roughly 6% of the faunal remains at Trapiche and only in fauna from Sectors B and C. Butchery was less prevalent than burning at the site (Figure 8.23, Table 8.6). Of the butchery observed, cuts were the most frequent, with 61% (n=56) of the total. However, hacks (26%, n=24) and sawing (13%, n=12) are also present. Taken together, these indicate variation in the processing of animal carcasses during butchery (primary butchery), as well as during food preparing and consumption (secondary butchery).

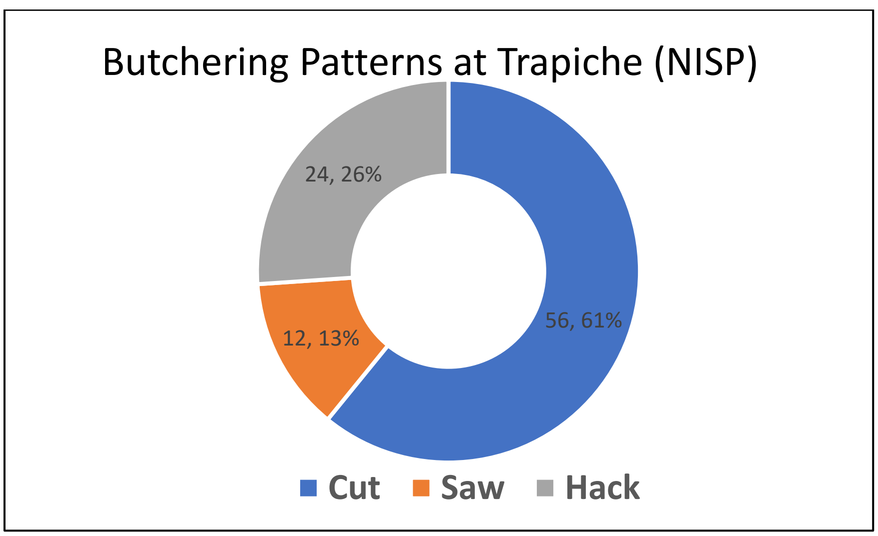

Figure 8.23: Proportion of butchering (NISP).

Table 8.6: Butchery Patterns by Unit (NISP).

Unit	15	17	19	21	23	24	25	Totals
NISP cut		1	1	5	37	10	2	56
NISP sawed			1	7		1	3	12
NISP hacked	2	3	2	5	9	2	1	24
NISP total butchered	2	4	4	17	46	13	6	92
NISP total for units with butchery	15	14	105	325	372	348	267	1446
% butchered of each UE	13.3	28.6	3.8	5.2	12.4	3.7	2.2	6.4
% butchered of total assemblage	**0.1**	**0.3**	**0.3**	**1.1**	**3.1**	**0.9**	**0.4**	**6.2**

Large mammals, such as horse and donkey, sheep/goat, and camelids displayed the entire variation of butchery, with cuts, saws, and hacks (Figure 8.24). Sawing likely indicates purchase at a market or in the form of a standardized cut. Sawing is also present on the remains of pork and beef, indicating their purchase in a market environment. Guinea pig is the only taxa that had only one type of butchery (cuts), likely due to its small size and relative ease with which its carcass is disassembled.

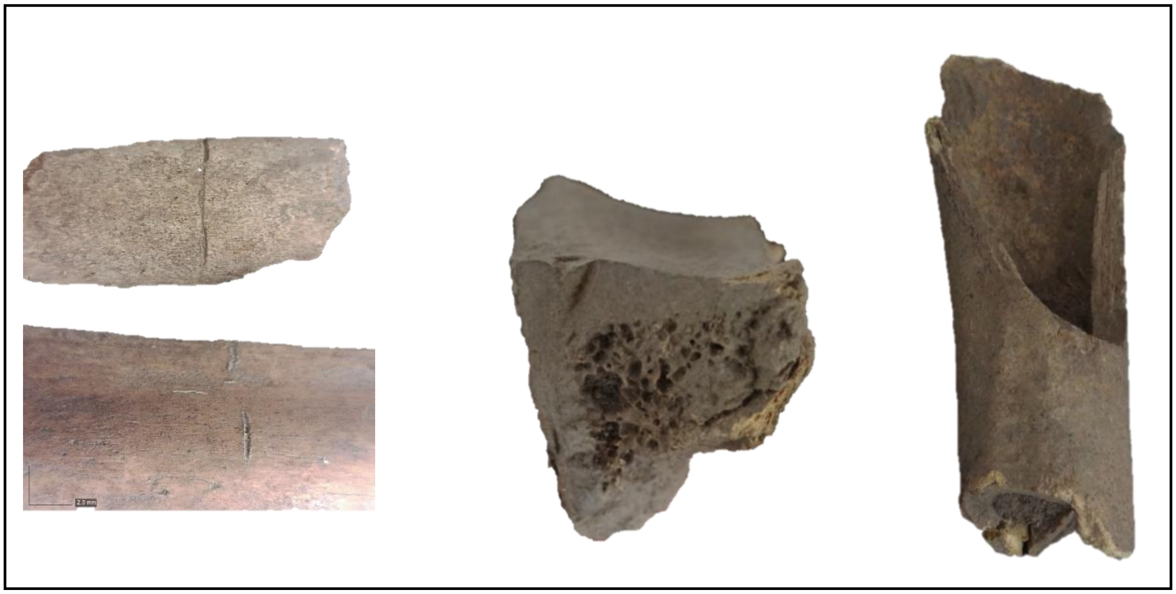

Figure 8.24: Examples of butchery at Trapiche. (Left to right): cut marks, sawing, and hacks.

8.6.2 **Macro-Botanical Results**

Paleoethnobotanical analysis identified 17 botanical taxa at Trapiche (Table 8.7), including foods for consumption, as well as wild and industrial plants (Figure 8.25). Edible plants identified at Trapiche were quinoa (*Chenopodium quinoa*), chile pepper (*Capsicum bacctum*), peach (*Prunus persica*), grape (*Vitis* sp.), oxalis (*Oxalis* sp.) and purslane (*Portulaca* sp.). While we were unable to identify a species to the seed identified as oxalis (*Oxalis* sp.), I tentatively describe this taxon as “edible” as it is likely from the tuber, oca (*Oxalis tuberosa*).

The low frequency of edible plant material at Trapiche indicates residents were consuming foodstuffs not easily preserved in the archaeological record, such as foods that are eaten in their entirety (e.g., tubers). There is a strong likelihood that residents were consuming large amounts oca, potatoes, ullucu, and chuño (freeze dried potatoes), although confirmation of these staples relies on future starch and phytolith analyses.

Table 8.7: Plant Taxa.

Plant Use Category	Family	Genus and Species	English Common Name	Spanish Common Name
Staple	Amaranthaceae	Chenopodium quinoa	Quinoa	Quinoa
Staple	Chenopodiacea	cf. Chenopodiaceae	Quinoa, kañiwa	Quinoa, kañiwa
Spice	Solanaceae	*Capsicum* sp.	Chile	Ají
Spice	Solanaceae	*Capsicum baccatum*	Chile	Ají
Fruit	Rosaceae	*Prunus persica*	Peach	Durazno
Fruit	Vitaceae	*Vitis* sp.	Grape	Uva
Edible	Oxalidaceae	cf. *Oxalis* sp.[19]	Oxalis	-
Edible wild	Portulacaceae	*Portulaca* sp.	Purslane	-
Wild	Amaranthaceae	*Suaeda* sp.	Seepweed	-
Wild	Cactaceae	*Echinopsis* sp.	Hedgehog cactus	Cactus
Wild	Cactaceae	cf. Cactaceae	Cactus	Cactus
Wild	Malvaceae	*Malva* sp.	Mallow	-
Wild	Poaceae	cf. Poaceae	Grass	Pasto
Industrial	Cucurbitaceae	*Lagenaria* sp.	Gourd	Mate
Industrial	Cucurbitaceae	cf. Cucurbitaceae	Gourd	Mate
Industrial	Cyperaceae	*Scirpus* sp.	Sedge, bullrush	Totora
Industrial	Cyperaceae	*Eleocharis* sp.	Sedge, spikerush	-

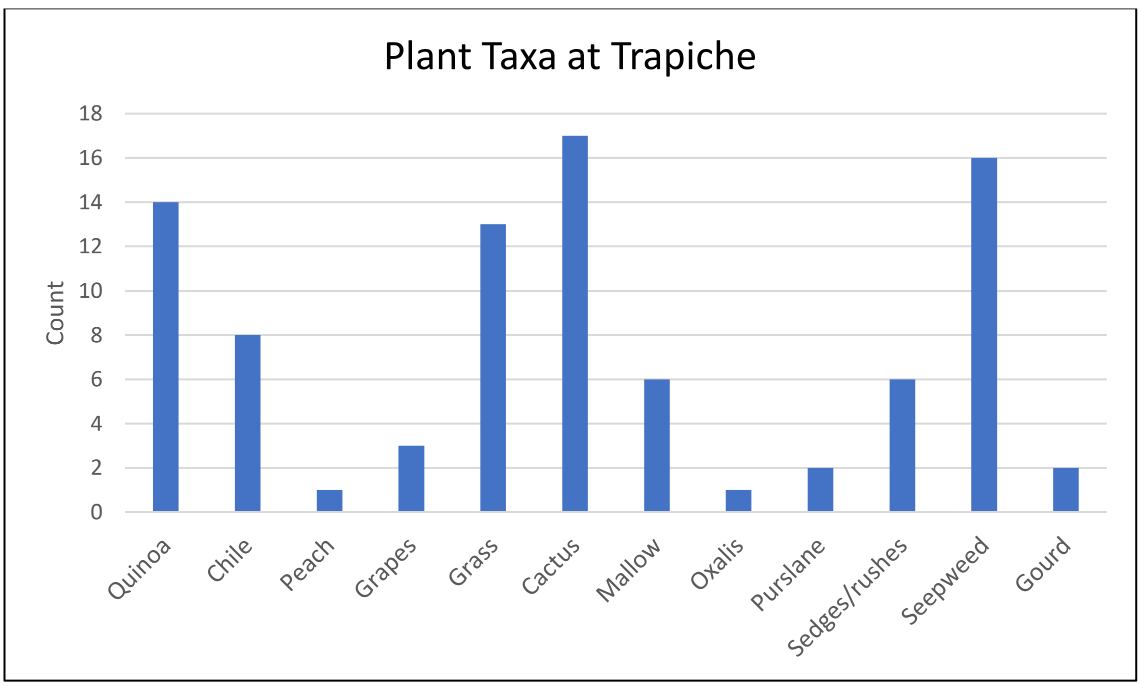

Figure 8.25: Plant taxa counts.

[19] *Oxalis* sp. is listed as "edible" as it may belong to *Oxalis tuberosa* and was found within a midden.

The macro-botanical assemblage (n=89) is dominated by wild species of plants (n=52; 58% of assemblage), including grasses (Poaceae), cacti (Cactaceae), seepweed (*Suaeda* sp.), and mallow (*Malva* sp.). Grasses at Trapiche likely included local *ichu* grass (*Jarava ichu*). Various types of cacti are also native locally, including hedge-hog cactus (*Echinopsis* sp.). Seepweed is the genus (*Suaeda*) of shrubs that grow in arid environments. Wild grasses may have entered the Trapiche assemblage through the burning of *taquia* (camelid dung) during domestic and industrial heating at ovens and fire hearths (Figure 8.26).

Of the wild species found at Trapiche, mallow is the only one not native to the Americas. At this point in time, it would have been an invasive species. It may have been at Trapiche to treat effects from stinging nettle. Many historical translations of the "Itapalluni" river translate the Aymara word to "stinging nettle." Finally, small numbers of the edible wild plant (n=2) purslane (*Portulaca* sp.) were also identified.

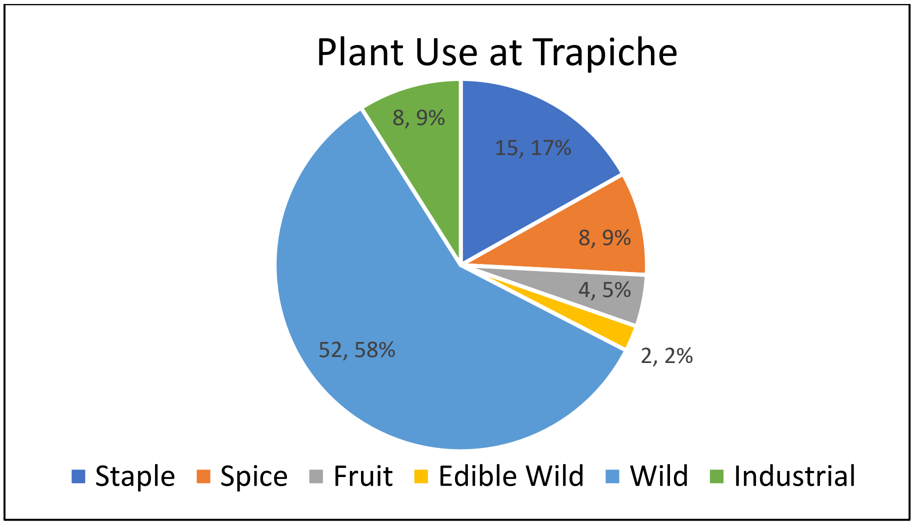

Figure 8.26: Plant use at Trapiche.

Industrial plants make up 9% of the assemblage (n=8) and include sedges (*Scirpus* sp. and *Eleocharis* sp.) and gourds (*Lagenaria* sp.). Sedges, such as the native *totora*, grow in marshy areas and were likely imported to Trapiche from lakes to use for industrial purposes such as building construction (wattle and daub), roof construction, matting, and basketry. Andean staple foods include quinoa (n=14) and possibly oca (*Oxalis* sp.; n=1) and make up 17% of the assemblage. Eurasian imported foods include fruits such as grapes (*Vitis* sp.) and peaches (*Prunus persica*) (n=4; 5% of assemblage). South American chili peppers (*Capsicum baccatum*), used for spice and flavoring, were also found at the site (n=8, 9% of assemblage).

A quick glance at the macro-botanical remains by sector (Table 8.8, Figure 8.27) indicates greater plant species richness in Sectors B (11 taxa) and C (12 taxa), than in Sector A (9 taxa). Quinoa is the only edible plant taxa to be found in all sectors. Fruits are rare, with only one peach pit found in Sector B, and grape seeds only found in Sector C. Purslane, an edible wild plant, is only found in Sector B. In contrast, wild plant taxa are found in every sector of the site. Industrial taxa are less prevalent, as sedges are only found in Sector C, while gourds are only found in Sectors A and B.

Table 8.8: Presence of Plant Taxa by Sector.

Plant Use	Plant	Sector A	Sector B	Sector C
Food	Quinoa	x	**X**[20]	x
Food	Chile	x		**X**
Food	Peach		x	
Food	Grapes			x
Food	Purslane		x	
Food	Oxalis		x	
Wild	Grass	x	**X**	x
Wild	Cactus	**X**	x	**X**
Wild	Mallow	x	x	x
Wild	Seepweed	**X**	**X**	x
Industrial	Sedges/rushes			**X**
Industrial	Gourd	x	x	

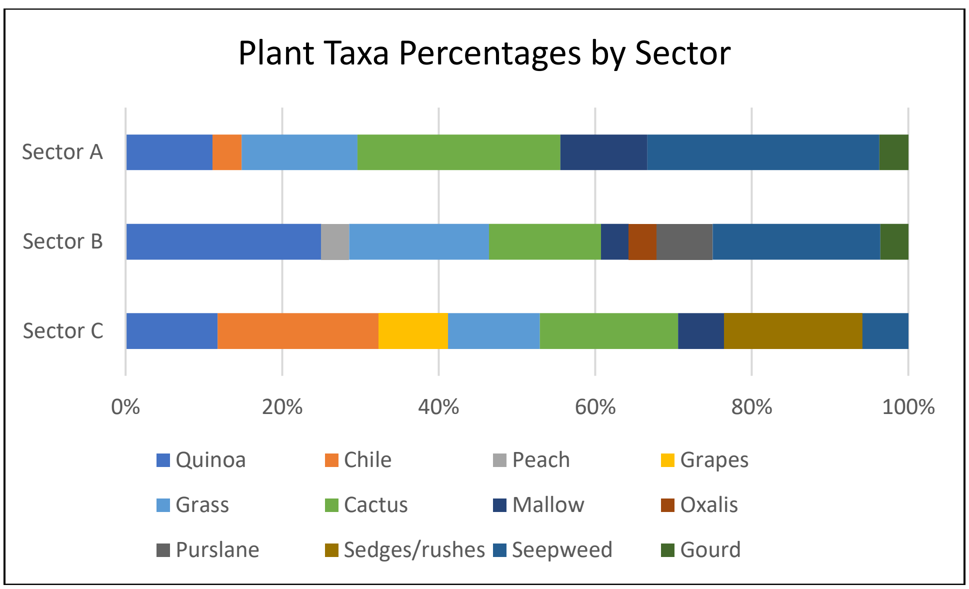

Figure 8.27: Proportion of plant taxa by sector.

[20] **X** = greater than 5; x = less than 5.

Intra-site trends are further revealed with plant taxa percentage of seeds per sector (Table 8.9). Plant taxa richness does not vary much between sectors (A=7, B=9, C=8), though it does vary between specific excavation units. Two units with the highest taxa richness were that of the overseer/owner (Unit 19) and the midden (Units 24 and 25), both with 11 taxa apiece. Others, such as Unit 17 (n=1) and Unit 21 (n=1) had only one identified taxa in total.

The presence of fruit and chile peper seeds at Trapiche are interesting (Figure 8.28). Grapes are only found in Sector C near the chapel, while peaches are only found in the owner/overseer's house (Unit 19). Chile peppers, an Andean staple used to season foods, was found in Sectors A and C, revealing laborers had access to some of their traditional spices and condiments.

Finally, I calculated ubiquity, standarized density, and relative taxa percentage by sector (Table 8.10). Ubiquity looks at overall presence of a taxa in an assemblage, counting the number of samples in which a taxon is present dividied by the total number of samples (Chiou 2017; Hastorf 1990, 2001; Popper 1988). At Trapiche, wild taxa are present in 80% of all samples in Sector A and 50% in Sector B, while they are in only 30% of samples in Sector C. Staple foods are present in 30% of all Sector A samples, 20% of Sector B samples, and only 5% of all Sector C samples. This reveals wild taxa and staple foods were more available across much of Sector A, and less so in Sectors B and C.

Standarized density divides plant count by sample volume, providing information on the quanity of remains per sample (Chiou 2017; Hastorf 1990, 2001). This calculation revealed that plant remains are very sparse at Trapiche. Sector A has a denser collection of industrial plants. Relative taxa percentage is the sum of all taxa in an assemblage. It is used to deterine how domintant a particular taxa is within an asemblage (Hastorf 1990, 2001). Spice taxa are dominat in Sector C, staple taxa in Sector B, and wild taxa in Sector A.

Table 8.9: Raw Counts and Percent Frequency of Plant Remains.

Sector	Unit	Context	Location	Cactaceae	Capsicum sp.	Capsicum baccatum	Chenopodiaceae	Chenopodium quinoa	Cucurbitaceae	Echinopsis sp.	Eleocharis sp.	Lagenaria sp.	Malva sp.	Oxalis sp.	Poaceae	Portulaca sp.	Prunus sp.	Scirpus sp.	Suaeda sp.	Vitis sp.	TOTAL
A	11	Laborer Residence	Structure 5	6	1	-	1	2	1	1	-	-	3	-	4	-	-	-	8	-	**27**
B	17	Admin	Structure 20	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	**1**
B	19	Overseer Residence	Structure 24	3	-	-	1	6	-	1	-	1	1	1	4	2	1	-	6	-	**27**
C	21	Multi-Purpose Building	Structure 27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	**1**
C	23	Midden	South Patio	-	1	-	1	1	-	4	1	-	-	-	3	-	-	2	1	2	**16**
C	24	Residence/ Storage	Structure 25	1	5	1	-	-	-	-	-	-	1	-	1	-	-	1	1	1	**12**
C	25	Midden	South Patio	1	-	-	-	2	-	-	-	-	1	-	-	-	-	1	-	-	**5**
			Total Count	**11**	**7**	**1**	**3**	**11**	**1**	**6**	**1**	**1**	**6**	**1**	**13**	**2**	**1**	**5**	**16**	**3**	**89**
			Percent Frequency	**12.4**	**7.9**	**1.1**	**3.4**	**12.4**	**1.1**	**6.7**	**1.1**	**1.1**	**6.7**	**1.1**	**14.6**	**2.2**	**1.1**	**5.6**	**18.0**	**3.4**	**100**

Figure 8.28: (Left) burnt chile pepper (*Capsicum baccatum*) from Unit 24, and (Right) a peach pit (*Prunus persica*) from Unit 19.

Table 8.10: Botanical Ubiquity, Standardized Density, and Relative Percentage Values.

Analysis	Sector	No. of Samples	Staple	Spice	Fruit	Wild	Industrial
Ubiquity							
	A	12	0.3	0.1	-	0.8	0.1
	B	17	0.2	-	0.1	0.5	0.1
	C	21	0.05	0.2	0.1	0.3	0.2
Standard Density (count/L)							
	A	12	0.07	0.02	-	0.04	0.46
	B	17	0.17	-	0.02	0.39	0.02
	C	21	0.06	0.09	0.05	0.22	0.09
Relative Taxa Percentage (%)							
	A	12	11.1	3.7	-	51.9	33.3
	B	17	25.0	-	3.6	46.4	25.0
	C	21	12.1	18.2	9.1	36.4	24.2

8.7 Lithic and Metal Results

8.7.1 Lithics

In total, 35 lithic artifacts were recovered from excavations at Trapiche, weighing 17,882 grams (Table 8.11). The majority of these came from Sector C (n=22; 63% of all lithics), although lithic tools were found in every sector and in 45% of all units. Most lithic tools and debitage was made from basalt and chert geologic sources (Figure 8.29). Two tools (a core and a flake) were made from obsidian. Most ground-stone tools, such as manos and metates, were made from sedimentary sandstone or limestone.

Table 8.11: Total Count and Weight of Lithics.

Sector	Count	Weight (g)
A	5	5,100.1
B	8	9,894.1
C	22	2,887.9
Total	**35**	**17,882.1**

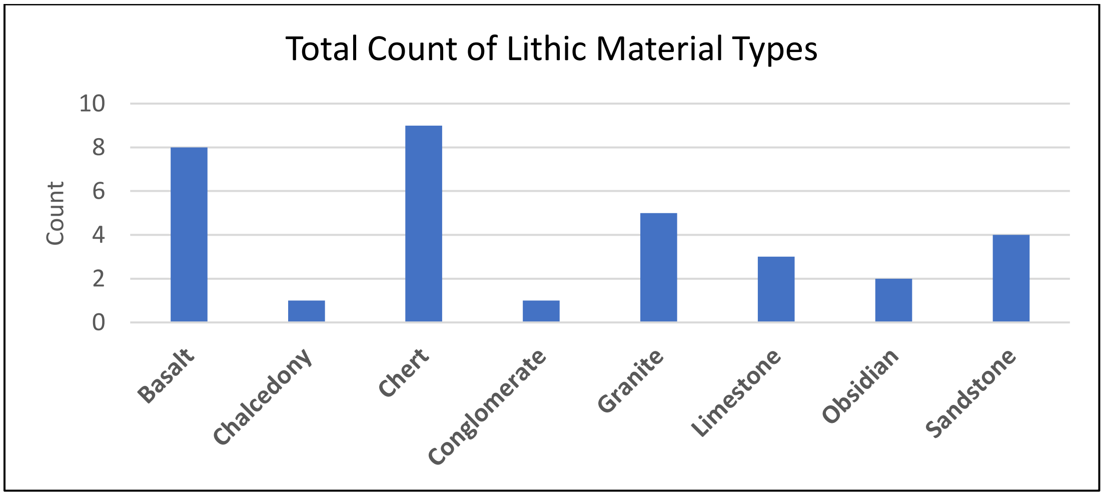

Figure 8.29: Count of lithic material types.

Six individual types of lithic tools were identified from excavations, including bifaces, cores, flakes/debitage, grinding stones, polishing stones, and scrapers (Figure 8.30). Most tools were categorized as grinding stones (n=15; 43% of lithics) and were likely used for both subsistence (processing of food) and work-related tasks (grinding ore, salt, and other add-ins). Grinding stones were found in all three sectors and in every unit with lithic artifacts (Figure 8.31). This was likely due to their multi-purpose use and speaks to the overall nature of life in a refinery (industrial tasks are done everywhere – even in "domestic" settings).

Flakes/debitage are the second most predominate tool type (n=11; 31% of lithics) and were found in Sectors A (Unit 11, laborer house) and C (Units 13, 21, 23, 24, and 25). Flakes came from a variety of materials (chert, obsidian, basalt, andesite, chalcedony) and indicate laborers were using any and all materials available to them to fashion tools. Lithic flakes that appear in "higher-status" contexts in Sector C were likely used by indigenous cooks, servants, or caretakers, likely women, most associated with domestic work. The presence of flake tools in 17th and 18th century residential contexts is interesting, as metal tools would have been available in the Andes for the prior 200+ years. Indigenous laborers likely did not have access to metal tools while working in the refinery and relied on local materials to fashion domestic tools.

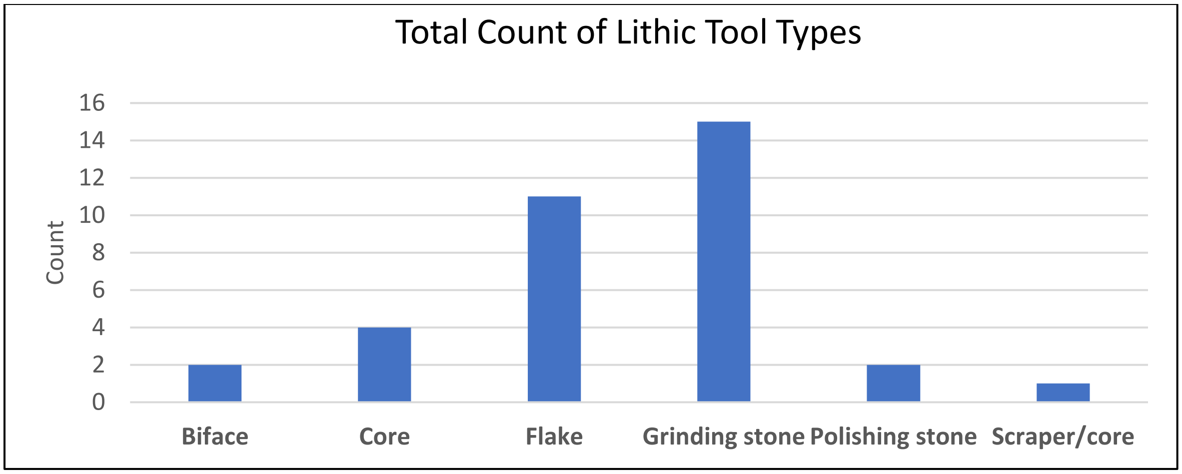

Figure 8.30: Count of lithic tool types.

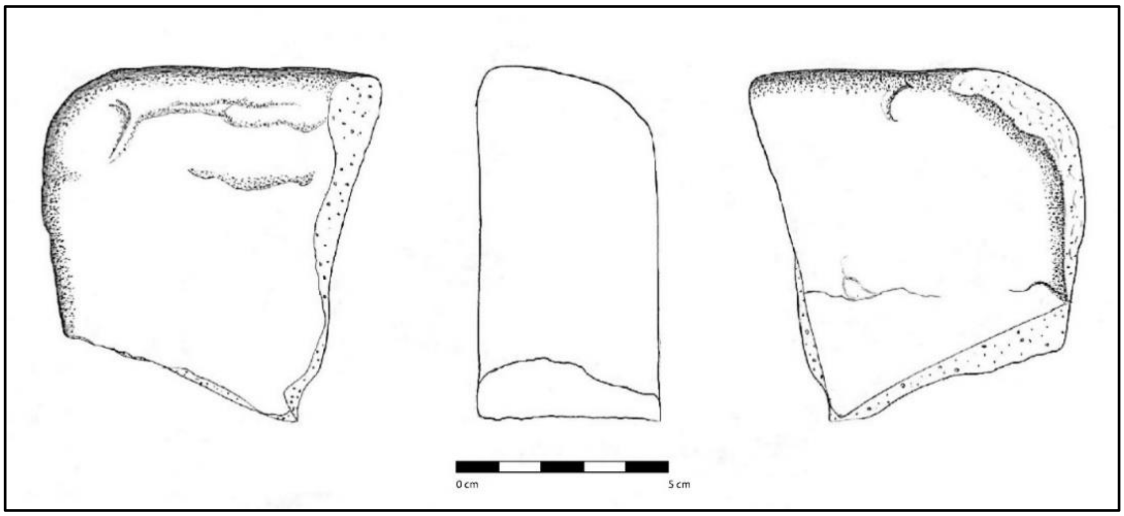

Figure 8.31: A grinding stone from Unit 19 in Sector B.

Cores, scrapers, and bifaces were also found in every sector at Trapiche and appear to concentrate in domestic households. They were found in Sector A, Unit 11 (laborer household), Sector B, Unit 19 (overseer/owner household), and Sector C, Unit 24 (caretaker household), as well as in the chapel in Sector C (Unit 13). Most of these tools were made from chert, but we also recorded cores made from basalt and obsidian. Many of the tools exhibited evidence of retouch and reuse (Figure 8.32).

The final category of lithic tool recovered at Trapiche was polishing stones, found on the surface of Patio 4 (Sector B) and Patio 5 (Sector C). These patios were the primary location for metallurgical processing of silver with mercury (see Chapter 6). Polishing stones may have played a part in this practice or were used for other activities related to producing pottery on-site. For images of some of the lithic tools recovered at Trapiche, see Figure 8.33 and Appendix D.

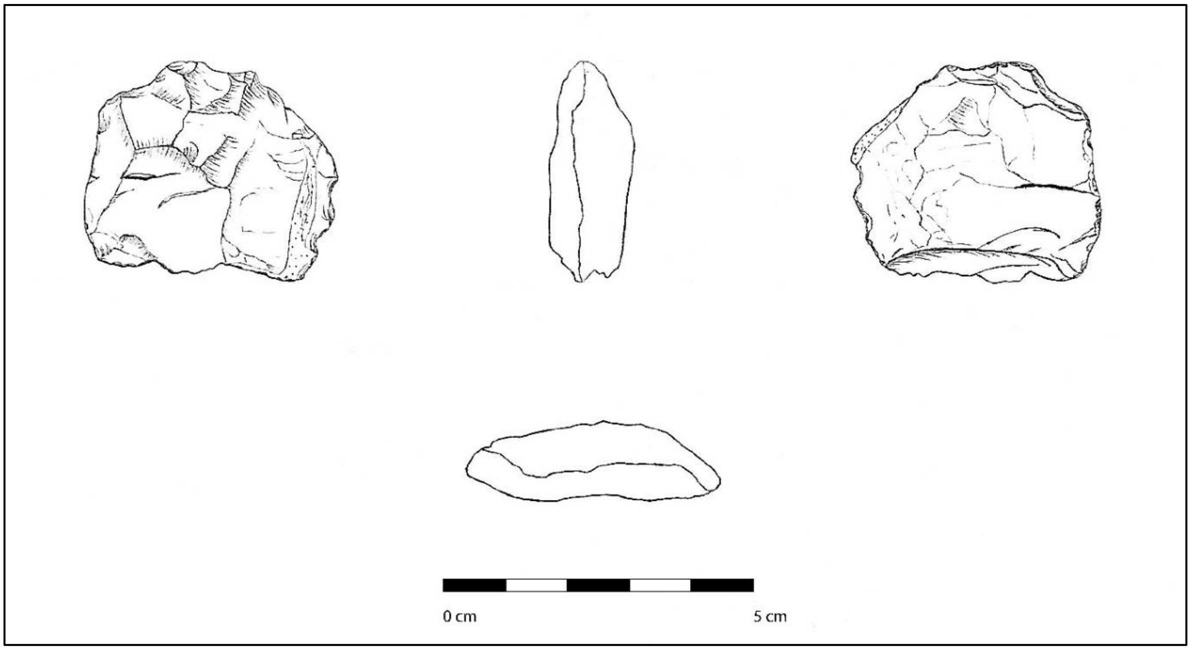

Figure 8.32: Retouched bifacial chopper uncovered inside a laborer household (Sector A, Unit 11).

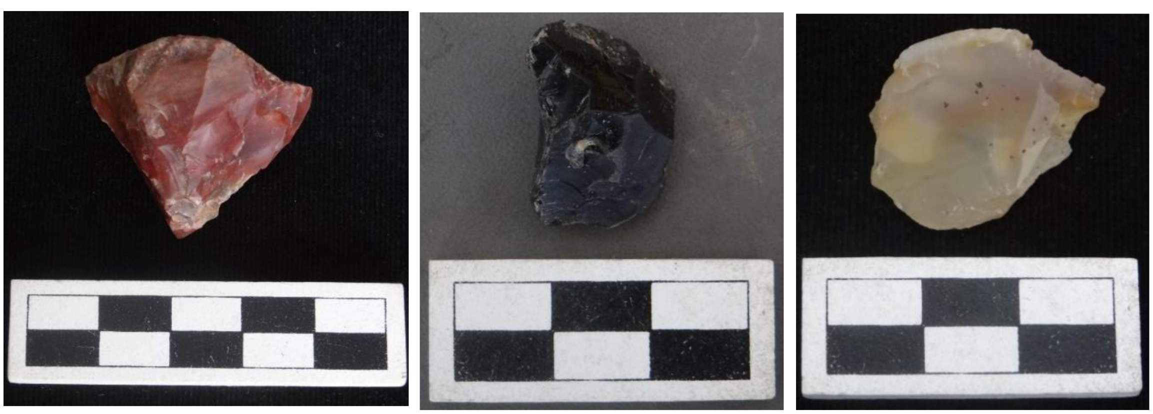

Figure 8.33: Lithic tools, including (Left to Right) a retouched scraper, an obsidean flake, and a chert flake.

When looking at the lithic assemblage by unit (Table 8.12), most lithic tools come from Unit 24 in Sector C (n=6; 21% of all lithics), as well as Unit 11 in Sector A (n=5; 18% of all lithics). Unit 11 is likely located within a laborer household, where we found evidence of a cooking hearth, as well as a spindle whorl, a small bead, and a llama figurine. Unit 24 has been slightly more difficult to define, as it was placed within a small structure adjacent to the chapel and has been referred to as the caretaker's house. Unit 24 has two wall niches, and we uncovered the presence of a hearth in the earliest floor occupation of the structure. Later periods of occupation within this structure suggest it was used as a house and later as a waste receptacle for burned trash. Over half of the lithics found in Unit 24 (including flakes and grinding stones) come from early occupation phases and floors, suggesting lithic tools are an important indicator of early period domestic space at Trapiche.

Lithic tools may also suggest indigenous spaces at Trapiche, as it was likely that laborers were not given or could not afford expensive metal tools for their personal domestic activities. Within Unit 19 (the house of the overseer/owner), the only lithic tools identified were grinding stones. No lithic tools used for cutting (scraper, flakes, etc.) were found in Unit 19, and metal may have been an alternative in this household (although we did not find direct evidence of this).

Table 8.12: Lithic Types by Unit.

Sector	Unit	Context	Biface	Core	Flake	Grinding Stone	Scraper/ core	Total	% Total
A	UE11	Laborer House	1	1	1	2	-	**5**	**17.9**
B	UE17	Admin	-	-	-	1	-	**1**	**3.6**
B	UE19	Overseer House	-	-	-	3	1	**4**	**14.3**
C	UE13	Multi-Purpose	-	2	1	1	-	**4**	**14.3**
C	UE21	Multi-Purpose	-	-	2	1	-	**3**	**10.7**
C	UE23	Midden	-	-	1	1	-	**2**	**7.1**
C	UE24	House/ Storage	1	-	3	2	-	**6**	**21.4**
C	UE25	Midden	-	-	1	2	-	**3**	**10.7**
		Total	**2**	**3**	**9**	**13**	**1**	**28**	**100.0**
		% Total	**7.1**	**10.7**	**32.1**	**46.4**	**3.6**	**100.0**	**-**

8.7.2 **Metals**

Objects made of metal were also recorded at Trapiche and varied from tools to housing hardware to debris from the refining process. We recorded 55 total objects that weighed a total of 1,554.1 grams. The majority came from Sector C (n=35; 63% of all metals). Eight different categories of metal were recorded, including door hinges, nails, ore, scrap metal, slag, a door lock, wire mesh, and unknown metals (Table 8.13, Figure 8.34). Additionally, we uncovered a lead musket ball and a silver coin, but these are discussed below under “special objects.”

Most metal objects were hand-wrought iron nails (n=16; 29% of all metals), followed by slag and waste debris from the refining process (n=15; 25% of all metals). Slag was found in all three sectors and usually not within domestic areas (the exception was small refuse middens within

Unit 19 and Unit 24). Nails were only found in Sectors B and C and may have been unattainable for indigenous house construction.

Table 8.13: Total Metals Identified.

Metal Type	Count	Weight (g)
Door hinge	2	76.2
Nail	16	109.8
Ore	2	67.1
Scrap metal	6	55.3
Slag	15	277.8
Door Lock	1	53.9
Unknown metal	12	913.0
Wire mesh	1	1.0
Total	**55**	**1554.1**

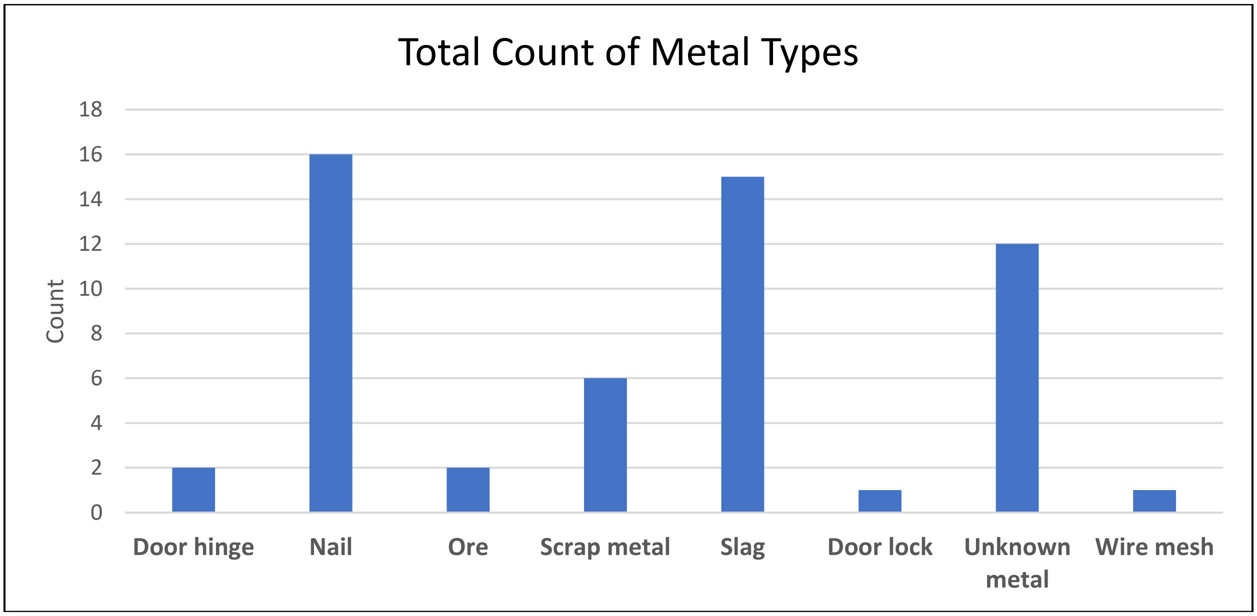

Figure 8.34: Count of metal types.

Other metals objects found at Trapiche include metal building hardware, including remnants of a possible door hinge and door lock, as well as various pieces of scrap metal, wire mesh, and unidentified metals (Figure 8.35). Door hardware was only found in Unit 19 and within the midden (Unit 23) and indicates higher status and access to metal goods in this area. The presence of door hardware near the overseer/owner house also indicates the importance of the structure, as most structures at Trapiche likely had no closeable doors. Padlocks were usually only reserved for store houses with important items, such as expensive tools and mercury and silver. It is interesting, therefore, that the overseer/owner was able to lock their door as well.

As mentioned above, hand-wrought iron nails were only found in Sectors B and C, with the vast majority uncovered in the midden in Unit 23 (n=7). Figure 8.36 and Table 8.14 show the variation in nail types identified at Trapiche including caret-head, scupper, lath, L-headed, and headless. All were hand-wrought and likely date to the middle colonial period.


Figure 8.35: Metal objects: (Left) cut copper, and (Right) a possible iron door hinge.

Figure 8.36: Hand-wrought nails: A-D) caret-head; E) caret-head or L-headed; F) lath; G) scupper; H) scupper; I) L-headed; J-K) headless (Flint and Flint 2003; Nelson 1963).

Table 8.14: Hand-Wrought Colonial Nail Types by Unit.

Nail Type	Use	UE16	UE17	UE19	UE23	UE24	UE25	Total
Scupper	Roofing	-	-	-	2	-	-	**2**
Caret-head	Frame	-	1	1	3	1	-	**6**
Headless	Floor/Trim	-	-	-	1	-	-	**1**
Lath	Floor/Trim	-	-	2	-	-	1	**3**
Unidentified	-	1	-	1	1	-	-	**3**
Total		**1**	**1**	**4**	**7**	**1**	**1**	**15**
% Total		**6.7**	**6.7**	**26.7**	**46.7**	**6.7**	**6.7**	**100.0**

8.8 Ceramic Results

8.8.1 Excavated Ceramic Assemblage

The total count of sherds from excavations was 2,323. Within Sectors A, B, and C, most sherds were uncovered from Sector C (Figure 8.37). The principal communal midden was in Sector C, and many broken or spent pots were found in this midden. When broken down into style (local, Inka, or colonial), the majority of ceramics from Trapiche were identified as the "local" Puno Bay style (n=398, 65% of all ceramics) (Figure 8.38). These tended to be earthenware, unglazed coarse red ware ceramics that were oxidized. Local paste had many large inclusions. In addition to local styles (65%), we identified Inka-like ceramics (n=47, 8% of all ceramics) and colonial style ceramics (n=164, 27% of all ceramics) (Figure 8.39).

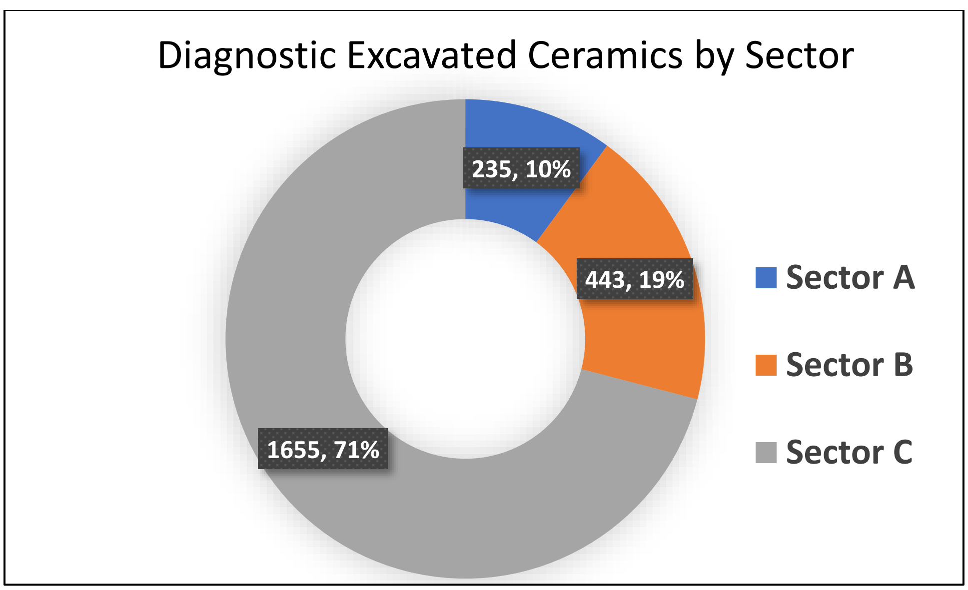

Figure 8.37: Ceramic counts by sector from excavations at Trapiche.

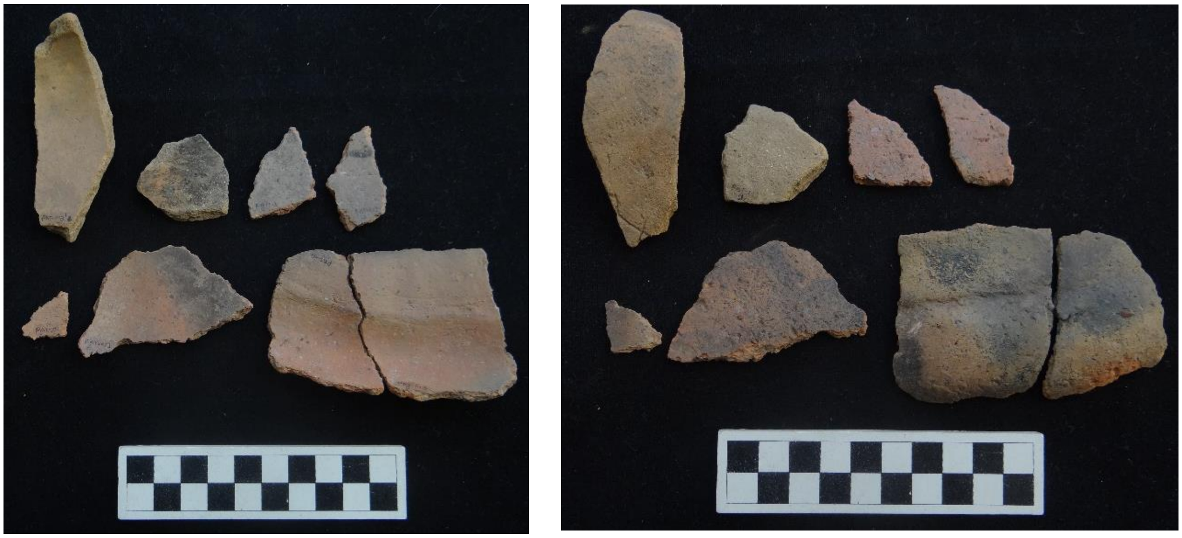

Figure 8.38: Local Puno Bay ceramic styles from Unit 19, Locus 013. (Left) interior (Right) exterior.

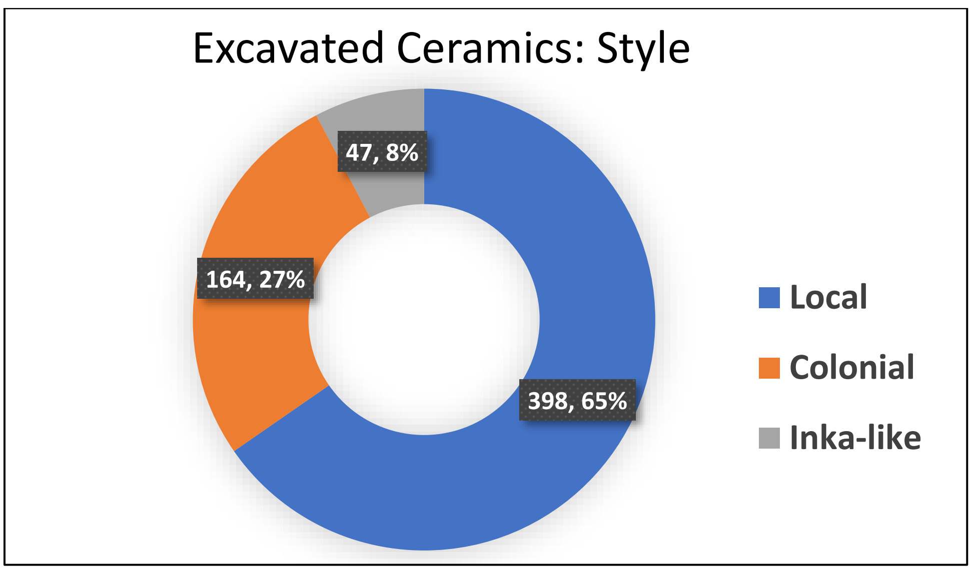

Figure 8.39: Proportion of ceramics by style from excavations.

Inka-like ceramics were found in the fewest numbers at the site (Figures 8.40 and 8.41). They were characterized as fine ware ceramics with red and brown paste colors and medium to fine paste texture with very few inclusions. They were also oxidized. Paste and thickness are consistent with local Inka styles, but the fragments were small and there was no visible surface painting, slip, or motifs on the fragments to be 100% certain they were local Inka. Therefore, we have decided to call them "Inka-like" for the time being. They may have been colonial produced ceramics, mimicking earlier Inka styles. Overall, the Inka-like styles correlate with serving wares, although the majority of fragments were too small to determine vessel function.

Figure 8.40: Inka-like pottery from Unit 24, Locus 203. (Left) interior, and (Right) exterior.

Figure 8.41: The interior paste of Inka-like pottery from Unit 24, Locus 214.

Colonial-style ceramics included Spanish olive jars (*botijas*) and majolica (*mayolica*) tin-glazed pottery (Figure 8.42). These pastes were red to pink fine-grained pastes with 5-10% inclusions. Many had wheel marks or scraping marks, indicative of construction evidence. Construction method of vessels appears to follow style, as the majority (97%) of all vessels at Trapiche were constructed by hand and were not mass produced on a wheel (Figure 8.43). Colonial ceramics were the exception, and some were produced on a wheel.

Figure 8.42: Colonial pottery from Unit 23, Locus 163. (Left to Right): interior, exterior, and paste.

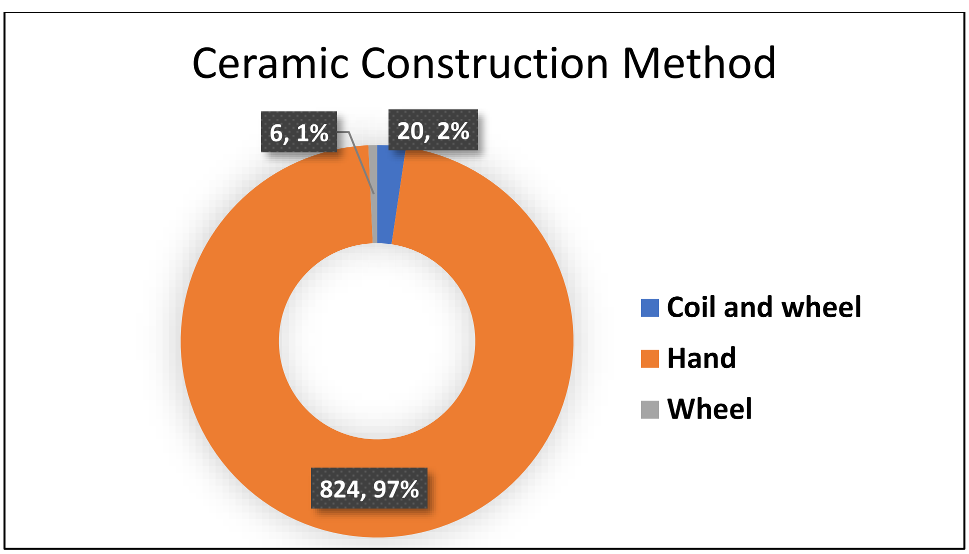

Figure 8.43: Proportion of ceramics by construction method.

Ceramic forms were identified when possible from the excavated ceramics (Figure 8.44). The most prevalent ceramic form were jars (n=441; 65% of all forms) and represent many types of storage containers. Plates and bowls make up 24% of the forms (n=163), signally a high percentage of serving and consuming wares. Cooking wares (pots or *ollas*) make up only 6% of vessel forms (n=41). The rest of the forms are related to silver refining (brazier/lids) and textile/pottery production (modified sherd/spindle whorl). The high amount of serving forms indicates a focus on distributing and serving food, with less focus on cooking. This may indicate cooking was done in select locations, and food was distributed to workers from these locations.

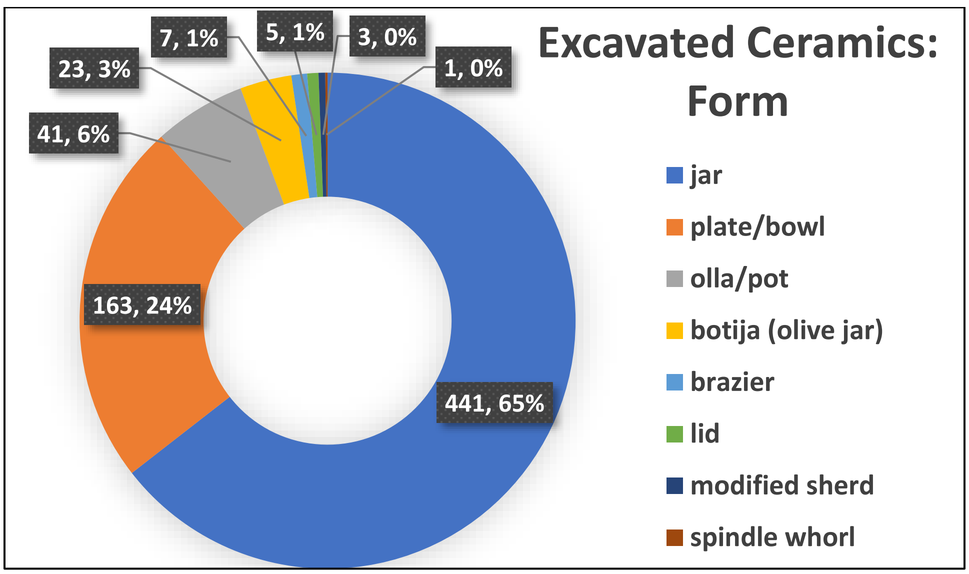

Figure 8.44: Proportion of ceramics by form in excavations.

8.8.2 **Ceramics by Sector**

Ceramic styles varied by sector as well (Figure 8.45). Colonial style ceramics make up 47% of all Sector B ceramics, while local styles tend to dominate Sector A (84%) and Sector C (65%). Inka-like ceramics are only present in relatively higher levels in Sector C (11%). Further chi-square analyses reveal very significant and moderately strong differences of ceramic styles between Sectors A, B, and C ($\chi^2 = 59.8$, $df = 4$, $p < 0.001$, *Cramer's V*=0.222).

Most Inka-like styles come from Unit 24, which is the proposed caretaker house next to the church and may represent a higher-status indigenous caretaker of the area. The higher percentage of colonial style ceramics in Sector B signals this area as one of silver refining production and storage, with higher amounts of colonial period industrial and storage vessels. The high amount of local style pottery in Sector A corresponds with the laborer houses, indicating they may have provided their own ceramic wares. A different interpretation would be that these ceramics were purchased locally by the overseer or refinery owner, for use within the refinery.

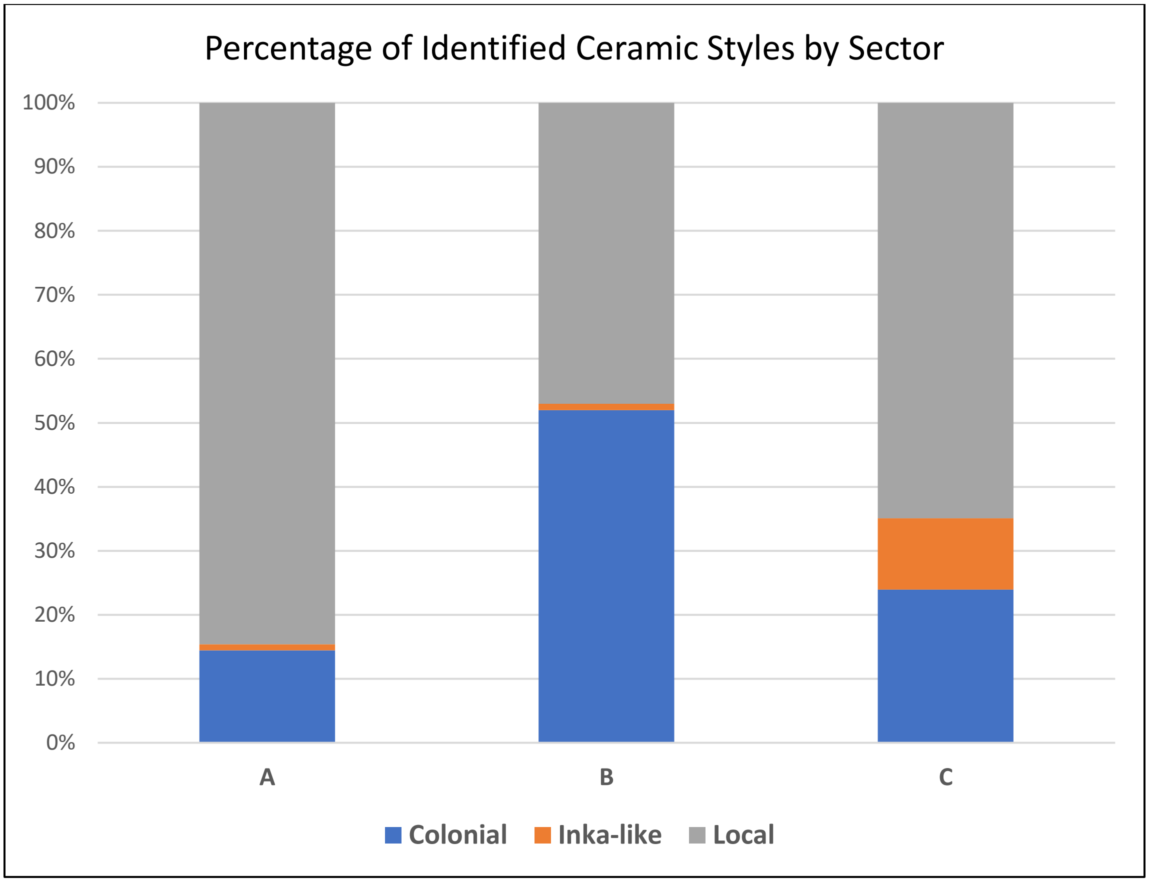

Figure 8.45: Percentage of identified ceramic styles by sector.

Ceramic wares also differed by sector (Figure 8.46). Chi-square analyses reveal very significant and moderately strong differences of ceramic ware proportions between Sectors A, B, and C ($\chi^2 = 317.7$, $df = 14$, $p < 0.001$, *Cramer's V*=0.262). Most noticeable is the high amount of unglazed coarse (n=57; 24%) and painted wares (n=58; 25%) in Sector A, relative to those proportions in Sectors B and C. These may indicate specific, local wares used primarily by indigenous laborers, which correlates to the "local" style ceramics identified there. Also relevant is the presence fine ware, Inka-like, and *botija* wares in Sector C, near the chapel (Structure 27). Most of these (n=57; 53%) come from Unit 24, the possible caretaker's residence. In contrast, most of the tin-glazed majolica in the entire assemblage come from the communal midden in Units 23 and 25 (n=33; 77%).

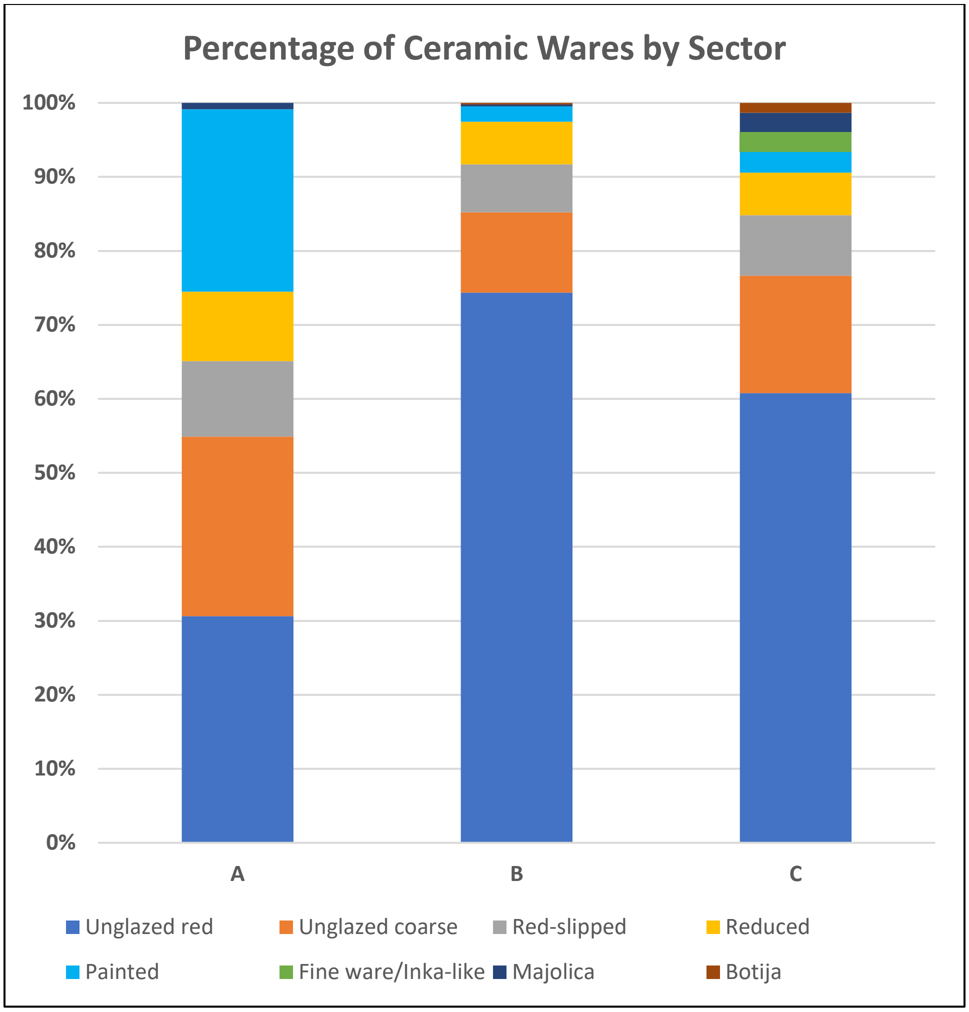

Figure 8.46: Percentage of identified ceramic wares by sector at Trapiche.

Ceramic form and function also differed by Sector (Figure 8.47). Most notable is the relatively large percentage of serving wares identified in Sector A, relative to the percentage of cooking wares and storage wares. Serving wares make up 74% (n=43) of all Sector A ceramics. This is in contrast to the lower proportions of plates/bowls in Sectors B (10%) and C (22%). Chi-square analyses reveal very significant and moderately strong differences of ceramic ware proportions between Sectors A, B, and C ($\chi^2 = 118.4$, $df = 14$, $p < 0.001$, *Cramer's V*=0.298).

Storage wares are relatively high in Sectors B and C and indicate that storage (likely of supplies and silver and mercury) was isolated to Sectors B and C, away from the laborer houses.

The high amount of serving wares in relation to cooking wares in Sector A indicates laborers were provisioned with food from a centralized area and were not in total control of their own cooking or food supply. These serving wares were either plates or bowls, so it appears that laborers were eating traditional soups and stews. Cooking wares were found in the same relative proportion in all three sectors, even in Sector A, which had a very high amount of serving wares. This indicates that some cooking was likely happening across the entire site, although it seems like it was centralized inside a few specific households.

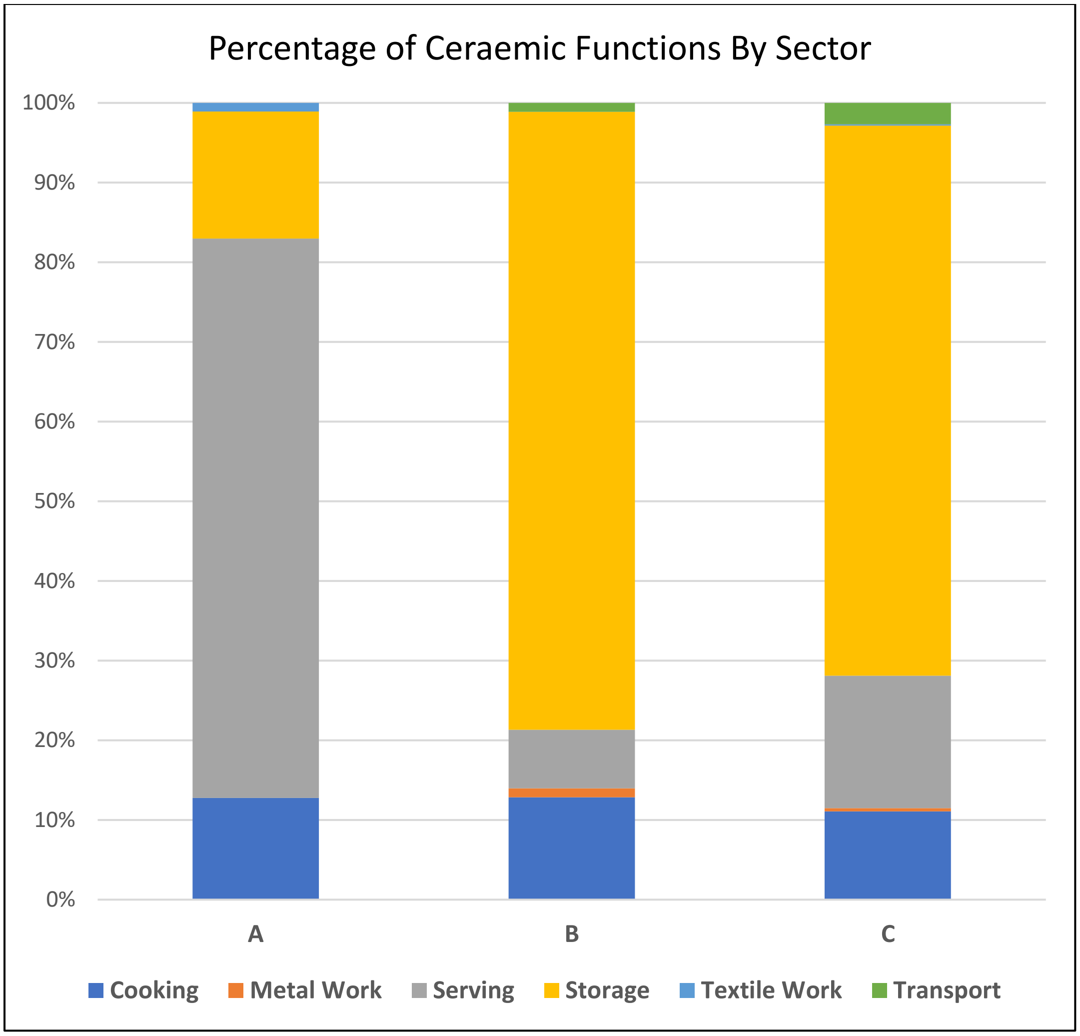

Figure 8.47: Percentage of identified ceramic functions by sector.

8.8.3 **Ceramics by Occupation Period**

As noted previously in this dissertation, the majority of excavation units at Trapiche did not include useful stratigraphy, so change-over-time was difficult to assess in the majority of artifact assemblages. Ceramics made up the largest artifact category, so it was possible to look at variation by occupation period across the site, as well as more specifically in Sector C (Units 13, 21, and 24).

To gain a broad picture of change-over-time, I first looked at excavated ceramics vs. surface ceramics (Figures 8.48, 8.49, and 8.50). Here, surface ceramics are a stand-in for the last occupational phase of the site, and excavation ceramics signify a generalized "earlier" occupational phase. This separation made it possible to investigate change-over-time in Sectors A and B, which did not have meaningful stratigraphy. The three most relevant ceramic categories were style, ware, and function, as other ceramic attributes were hard to assign due to fragmented surface ceramic remains. This likely affected our ability to determine accurate style, ware, and function as well, and these results should be taken as semi-quantitative only.

Inka-like ceramic styles were only identified in the "earlier" excavation contexts. Painted ceramics are also very rare in surface finds (n=1). Cooking ceramics were also only identified in excavation contexts. While Inka-like, painted, and cooking ceramics *may* indicate an earlier phase of occupation at Trapiche, it is more likely these differences are due to the depositional effects on ceramic surfaces, leading to less accurate identification in surface ceramic finds. Chi-square analyses of ceramic style by period (excavation vs. surface) revealed relatively significant, but rather weak differences ($\chi^2 = 11.73$, $df = 4$, $p = 0.019$, *Cramer's V*=0.092).

Differences in ceramic ware by occupation period were more pronounced ($\chi^2 = 48.9$, $df = 4$, $p < 0.000$, *Cramer's V*=0.132), with very significant and relatively strong differences. Red-slipped ceramics, as well as *botijas* and unglazed ceramics were more frequent in surface remains, while painted and fine ware ceramics were much more prominent in excavated remains.

Differences in ceramic function by occupation period were also more pronounced than style ($\chi^2 = 26.24$, $df = 3$, $p < 0.000$, *Cramer's V*=0.142), with very significant and relatively strong differences. Again, cooking ceramics were only found in excavation contexts. However, the majority of serving, storage, and transport ceramics also came from excavated contexts. This likely indicates that surface vs. excavated contexts is not a very reliable indicator of change-over-time for ceramic function, due to the difficultly of assigning function to small, worn ceramic fragments recovered on the site's surface.

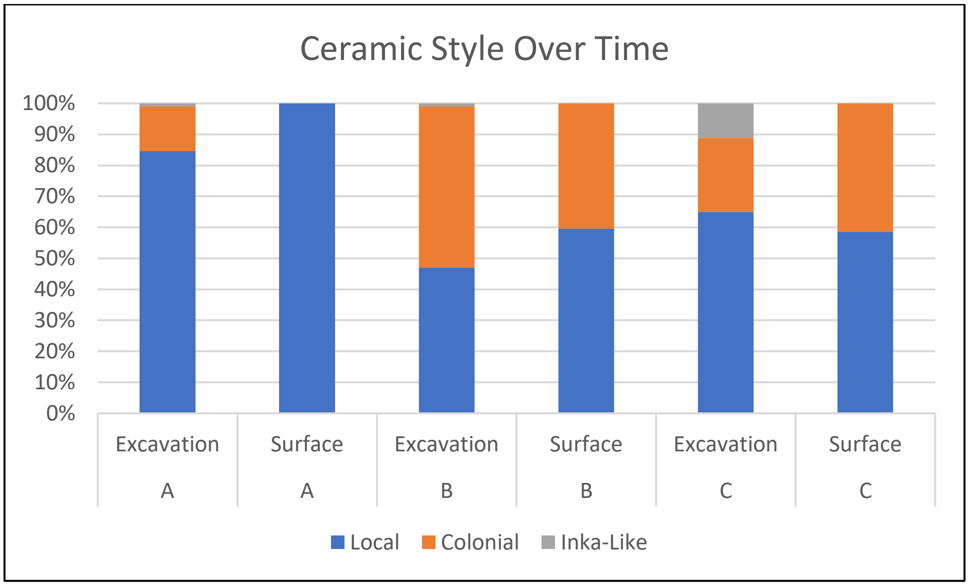

Figure 8.48: Excavated vs. surface ceramic styles by sector.

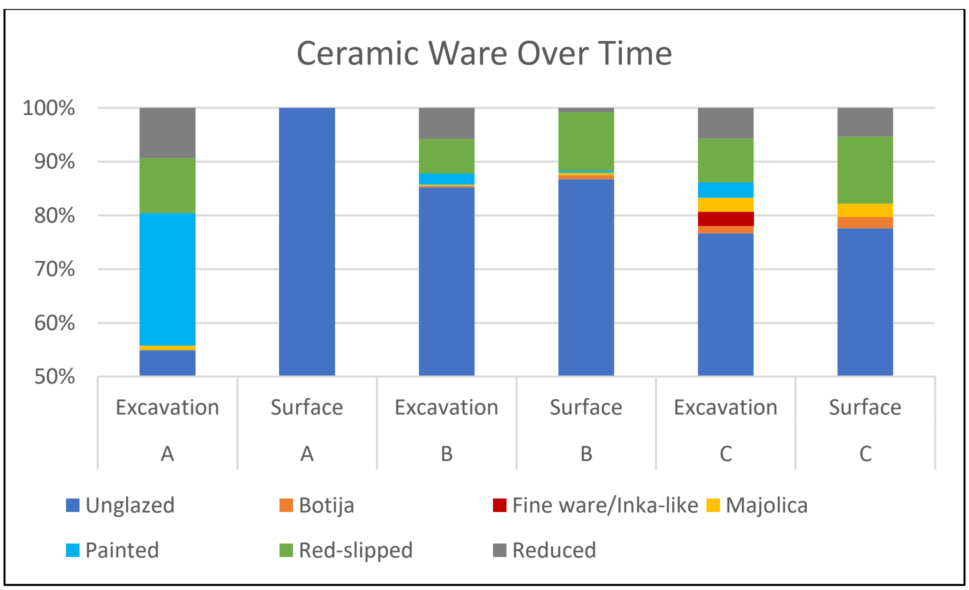

Figure 8.49: Excavated vs. surface ceramic wares by sector.

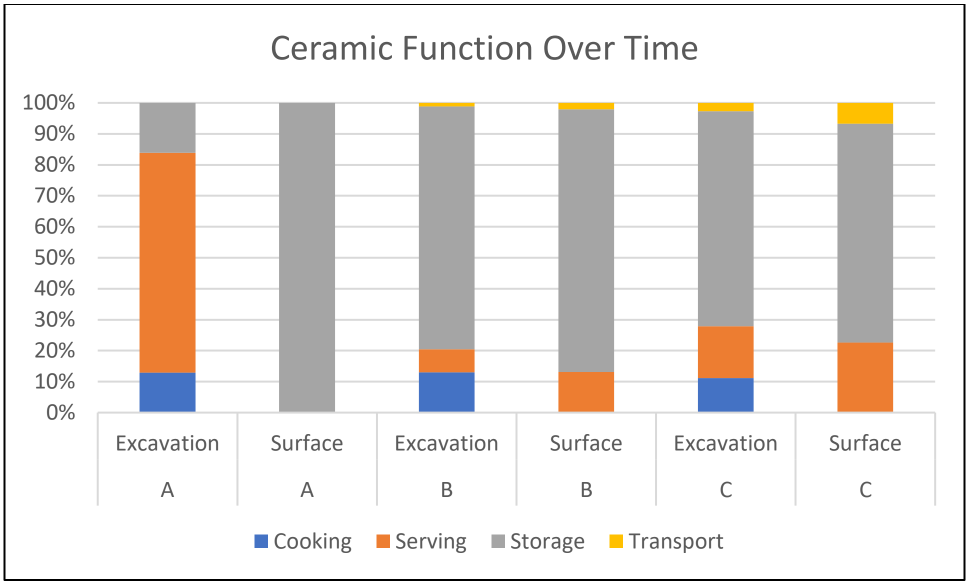

Figure 8.50: Excavated vs. surface ceramic function by sector.

We also looked at occupation period within units that had more detailed stratigraphy and clearer periods of occupation. These were all located in Sector C and were within Units 13, 21, and 24. Units 13 and 21 were located in Building 27 (the possible chapel), and Unit 24 was located in Building 25 (the possible caretaker's house).

Unit 24 had three defined occupational stages (earliest: floor; middle: fill; and latest: surface), referred to as Phases III, II, and I. Unit 24 analysis of style, ware, and form can be found in Figures 8.51, 8.52, and 8.53. Unit 24 ceramic styles did differ by occupational phase. The earlier occupation, Phase III, had more colonial ceramics, in comparison to the middle and late phases. Colonial sherds made up 83% of all Phase III sherds. Inka-like sherds are much more prevalent in Phase II, the fill event (95% of all Phase II ceramics). Chi-square analyses reveal very significant and moderately strong differences of ceramic style proportions between Unit 24's phases (χ^2 = 28.25, df = 4, p < 0.001, *Cramer's V*=0.363).

Unit 24 ceramic wares also varied significantly across Phases (χ^2 = 41.95, *df* = 10, *p* < 0.000, *Cramer's V*=0.311). The fill event, Phase II, had the largest proportion of *botijas*, fine wares, and red slipped wares, while the earlier Phase III had the most painted wares (50%), and the latest occupation, Phase I, had the most reduced wares (57%). Ceramic function also showed significant differences between occupations phases (χ^2 = 17.24, *df* = 6, *p* = 0.008, *Cramer's V*=0.326). No cooking ceramics were found in Phase III, although serving ceramics were quite prevalent (41%) in this earliest phase. Phase II, the fill event, had the most storage (77%) and transport ceramics (54%).

Overall, the earliest occupation of Unit 24 was dominated by colonial, painted, serving wares. The middle phase was dominated by fine wares and red slipped wares, as well as *botijas*, used for storage and transport. The final phase had reduced wares.

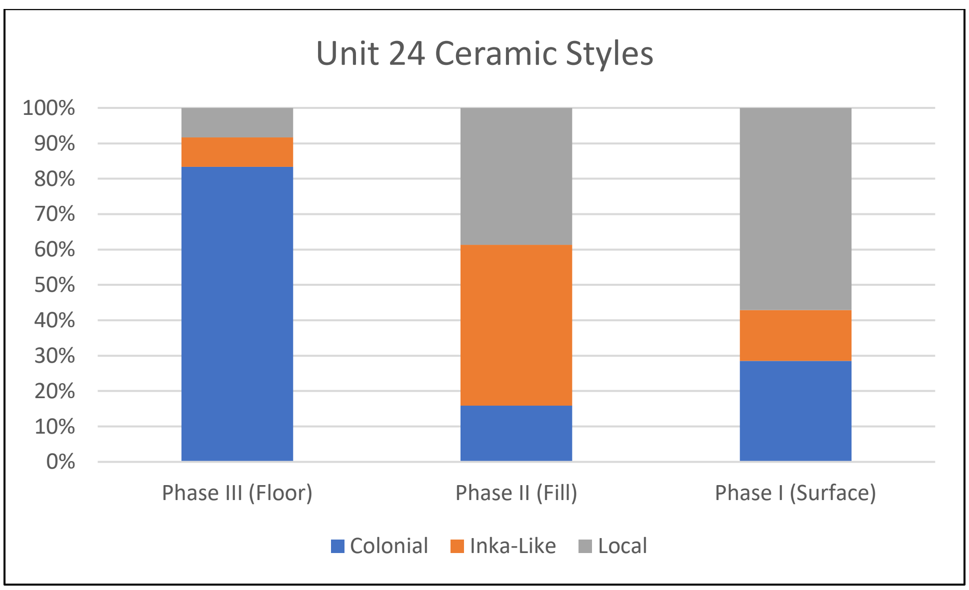

Figure 8.51: Unit 24 ceramic styles by phase.

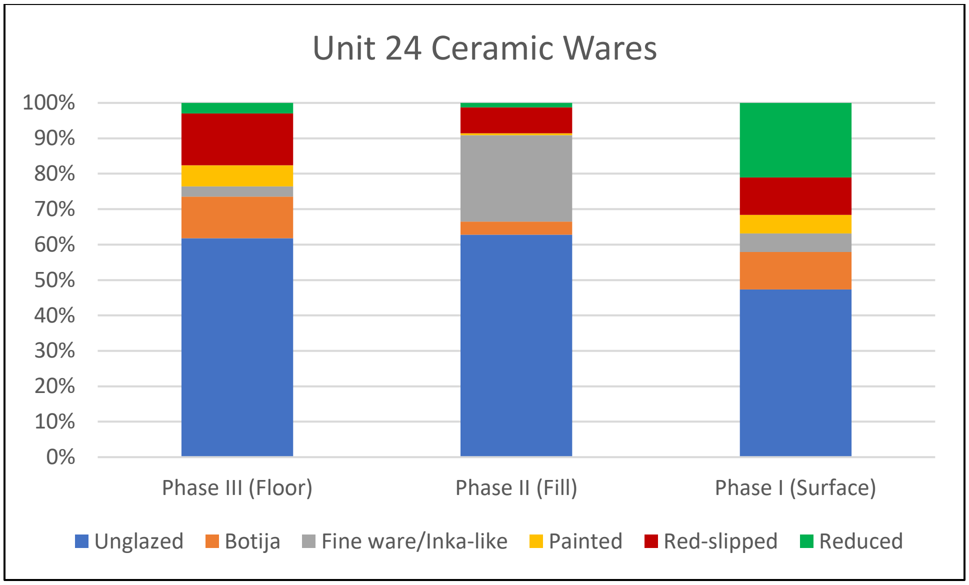

Figure 8.52: Unit 24 ceramic wares by phase.

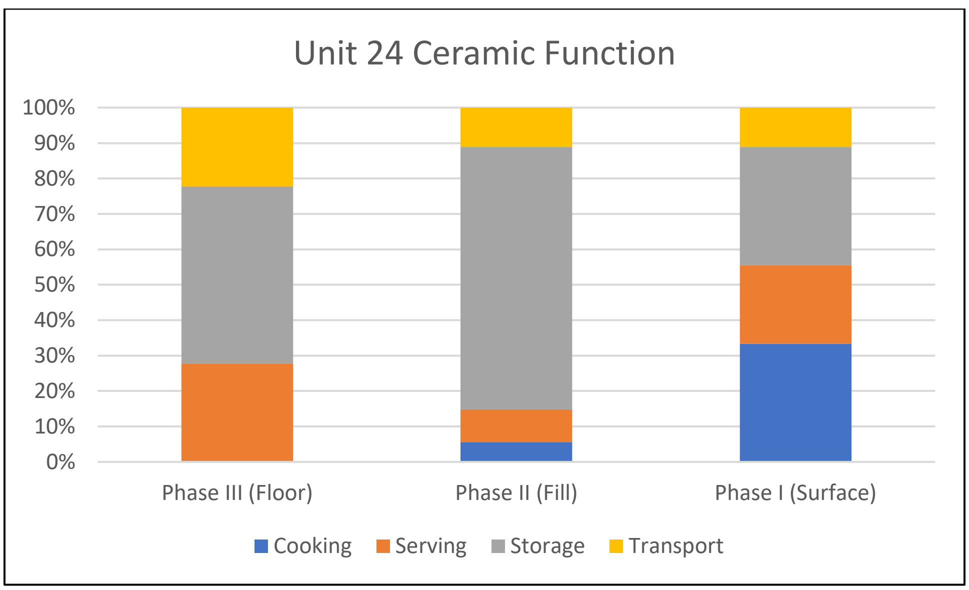

Figure 8.53: Unit 24 ceramic function by phase.

The other building at Trapiche to have multiple stratigraphic phases was Building 27, the possible chapel. Within this building, Units 13 and 21 had five discernible occupational stages: floor A; floor B; burning; fill; and surface. These were referred to as Phases V, IV, III, II, and I (see Appendix C for more detail). Building 27 analyses in style, ware, and form by phase can be found in Figures 8.54, 8.55, and 8.56.

Building 27 ceramic styles also differed by occupational phase. Phases V and III only had colonial ceramics. Phase II (the fill) was the only phase to have Inka-like ceramics. Chi-square analyses reveal a relatively significant and strong differences of ceramic style proportions (χ^2 = 14.18, *df* = 8, *p* = 0.077, *Cramer's V*=0.438).

Differences in ceramic wares were also noted, although less significant and strong than style differences (χ^2 = 32.24, *df* = 24, *p* = 0.121, *Cramer's V*=0.142). Unglazed ceramics make up the majority of all ceramic wares in Building 27 (above 80% for all phases). Similar differences, being less significant and strong, were also noted for ceramic function (χ^2 = 20.72, *df* = 12, *p* = 0.055, *Cramer's V*=0.156). Storage ceramics make up the majority of all Building 27 ceramics (over 77% for all phases). There are no cooking ceramics in the final two phases (II and I), although we uncovered a high amount of serving ceramics in these phases (50% and 13%). A larger amount of transport (40%) and cooking (40%) ceramics were found in Phase IV (Floor B).

Earlier phases of Building 27 appear to be dominated by colonial ceramics used for storage, transport, and cooking. The later phases, including the fill, appear to have more serving ceramics and fine wares. It is interesting that in both Unit 24 and Building 27, Inka-like ceramics are concentrated in the fill event.

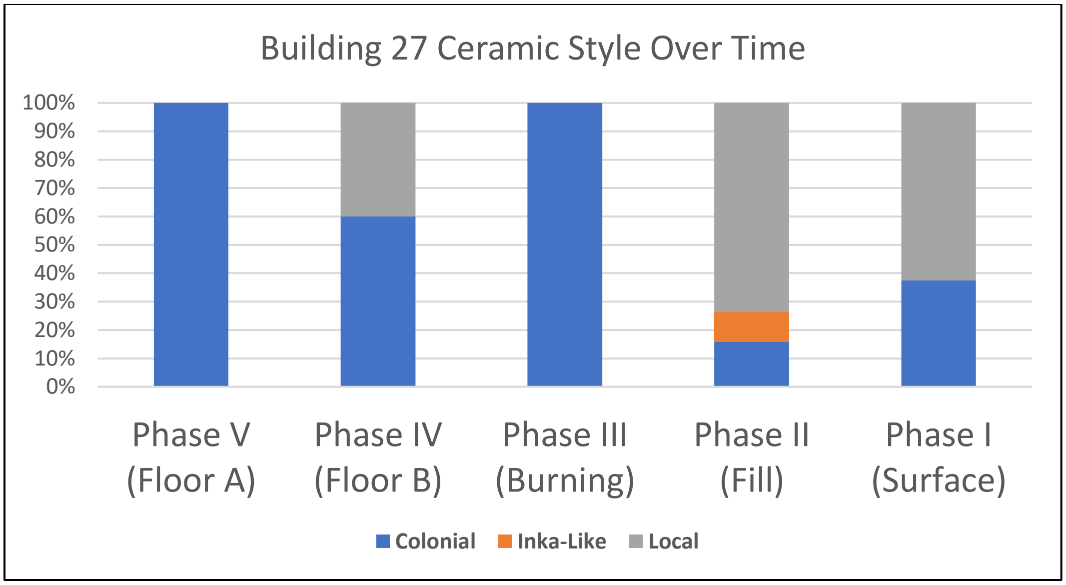

Figure 8.54: Building 27 ceramic styles by phase.

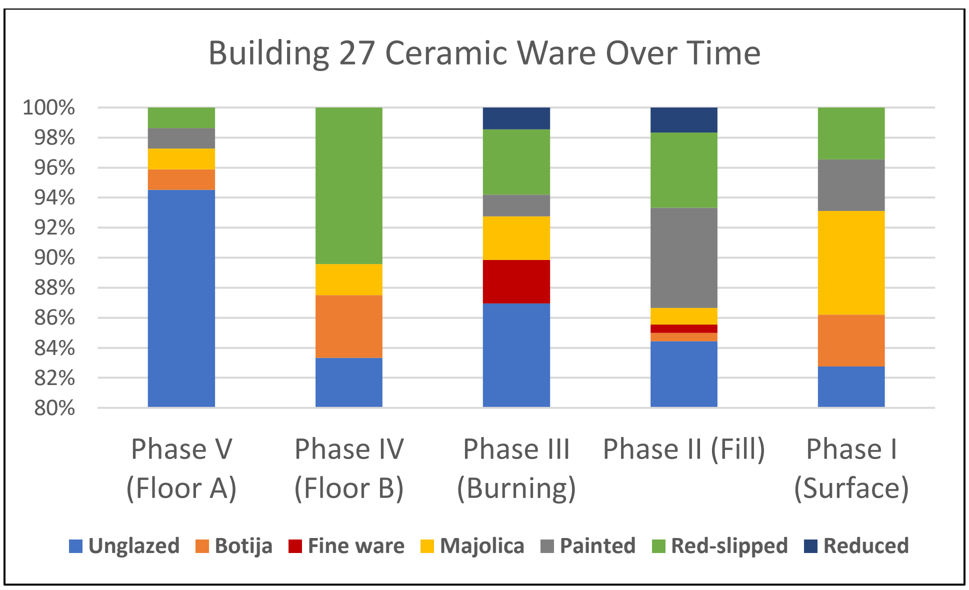

Figure 8.55: Building 27 ceramic wares by phase.

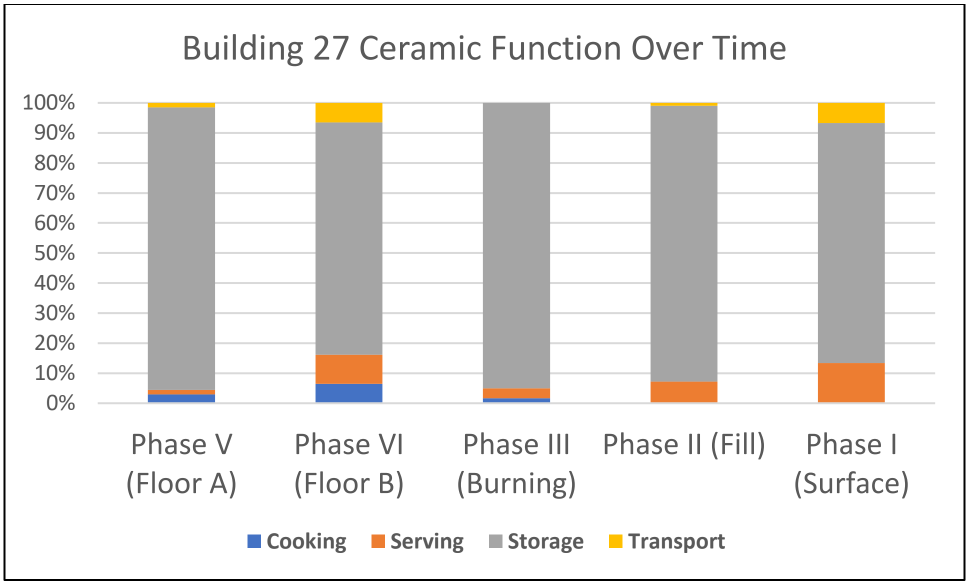

Figure 8.56: Building 27 ceramic function by phase.

8.8.4 **Burning**

Burning was recorded on all ceramics and the majority of burnt sherds were uncovered in Sector C (n=510, 74% of all burnt sherds) (Figure 8.57). If we look at burnt sherds by unit, the majority of burnt sherds come from the communal midden in Units 23 and 25. This indicates burning on ceramics is evidence of waste disposal.

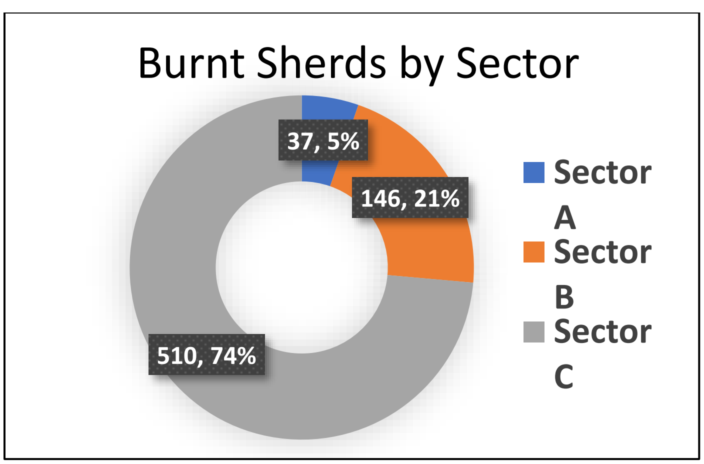

Figure 8.57: Proportion of burnt sherds by sector.

8.9 Special Finds Results

A variety of "special" objects were uncovered at Trapiche and did not fit into traditional artifact categories. These included items of jewelry, beads, *tupu* shawl pins, textile-making tools, a figurine, a silver coin, and a lead musket ball.

8.9.1 **Beads and Jewelry**

Excavations uncovered three beads at Trapiche, and each came from a separate unit and sector (Figure 8.58). In Sector A, we recovered a very small blue/green turquoise bead measuring 3 mm wide. This was found in Unit 11 in Sector A (the laborer house), from the heavy fraction taken from the floor of this structure. This bead was likely a 17th -18th century embroidery bead used as clothing decoration (Deagan 1987(v1):171-173). In Sector B, Unit 19 (the overseer/owner house), we uncovered a light green turquoise stone with brown and red flecks that may or may not have been used as a bead. It did not have a hole down the center. It may have been part of an ornamentation or inlay. In Sector C, in Unit 23 (the midden) we recovered a clear glass raspberry bead with raised bumps, common at Spanish colonial sites between 1700-1800 (Deagan 1987 (v1):174-178). This was likely used as jewelry in a necklace.

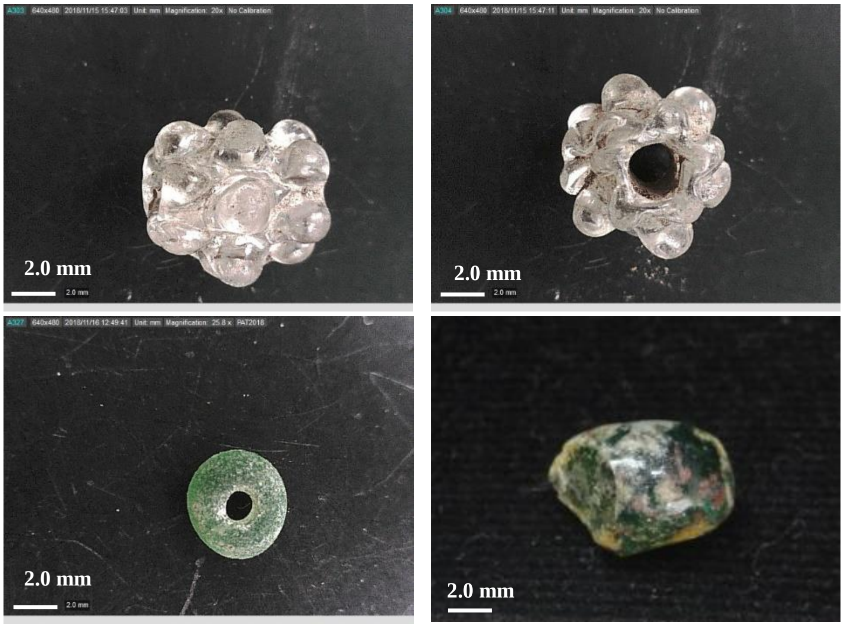

Figure 8.58: (Top right, clockwise): a clear raspberry bead, Unit 23; the same raspberry bead; a turquoise stone, Unit 19; and a small turquoise embroidery bead, Unit 11.

In addition to beads, we uncovered two *tupu* shawl pins made of copper, which were traditional shawl pins used by indigenous women of the Andes (Figures 8.59 and 8.60). These were only found in Sectors B and C. One was found in Unit 19 (the overseer/owner house) and one in Unit 23 (the midden). This indicates a woman was living with the overseer house at some point during occupation of the site.

Figure 8.59: Copper *tupu* shawl pins from (Left) Unit 23, and (Right) Unit 19.

Figure 8.60: An Andean woman with a *tupu* shall pin. Guaman Poma de Ayala 1615.

We also recovered two small, twisted copper wire rings from the midden in Sector C (Unit 23) (Figure 8.61). While we cannot be sure that these two rings were used as jewelry (they may have had some other function), they look similar to 18th century twisted copper wire rings from *criollo* sites in St. Augustine, Florida (Deagan 1987 (v2):125-127). A similar decorative technique using twisted wire was observed in Santa Rosa Pensacola, FL, where rosary "beads" were made of twisted copper wire (Smith 1965:71, 97). These rings may represent an indigenous or *mestizo* form of identity among residents at Trapiche.

Figure 8.61: Two twisted copper wire rings from Unit 23.

8.9.2 **Figurines**

We uncovered one stone figurine in the shape of a llama during excavations of Unit 11 in Sector A, the laborer residence. The figurine was found within wall collapse context immediately above the floor, perhaps deposited in the closing or abandonment of the building (Figure 8.62). This llama figurine was likely an *illa*, which was an indigenous offering used in religious rituals in the Andes, specifically used to grow the strength and power of camelid herds (Ponte 2013).

Figure 8.62: Llama figurine from Unit 11. (Left): side view of legs and rump, and (Right): tail view of legs and rump.

Stone llama *illas* were often described in colonial manuscripts as stone objects that contained supernatural power, and were only used during cyclical rituals, often related to fertility (Arriaga 1968 [1621]:220-30; Duviols 2003:112). For example, one fertility ceremony was reported to include the rubbing of a llama's body with *illas*, possibly to heal the animal or produce future fertility (Millones 1975:51). Whatever the reason the stone llama figurine was deposited in Unit 11, it does mark this space as related to indigenous beliefs and strengthens the hypothesis that the small structures in Sector A were used as laborer housing (Figure 8.63).

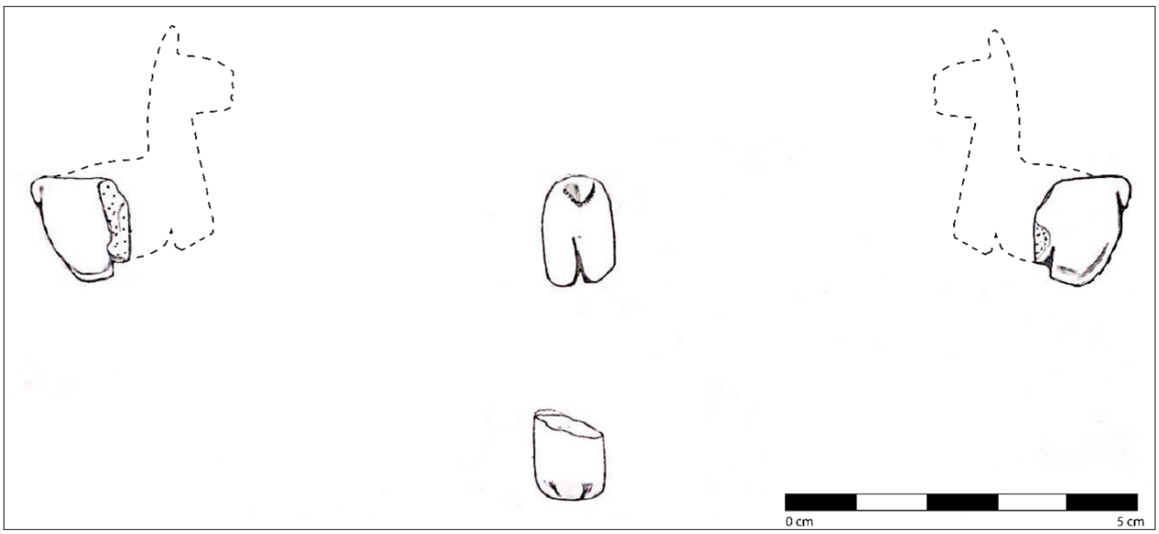

Figure 8.63: Illustration of the stone llama figurine from Unit 11, showing its possible full form.

8.9.3 **Macuquina/Silver Cob Coin**

One coin was found in excavations at Trapiche (Figure 8.64). It was found in Sector B, Unit 19, in the presumed owner/overseer's house above the prepared floor of the structure, in locus 042. The coin was identified as a "medio real macuquina" or a half-real silver-cob coin. On the reverse side of the coin, the Castile and León crest is visible, with the cross of Jerusalem ending in a t-bar, as well as the figures of two castle and two lions.

The obverse side of the coin is more worn (Figure 8.65), but it is possible to make out the monogram of King Phillip V, as well as a few numbers, which appear to indicate the date of either 1701 or 1711. The red dotted-line in Figure 8.65 traces the monogram of King Philip V. This looks like the letters R, A, and S, but it is actually the letters PHILIPPVS V overlaid together to form the monogram of the king. Philippvs V is the Latin spelling for Philip V.

These half-real, silver-cob coins were minted in the Potosí mint during 1701-1724, and again from 1728-1746 (Deagan 1987 (v2):241, 247-251, 254-255; Murray Fantom 2016:122-125). Judging from the worn date, we estimate the coin is from the earlier phase of production (1701 or 1711). This means that sometime in the 18th century, potentially early to midcentury, this coin was deposited at Trapiche. These dates align with the relative dating of the beads found at Trapiche, commonly produced around 1700-1750 AD. While the earlier silver rush in Puno was from 1660-1690 (Laicacota), the second silver boom (Cancharani) occurred later, from the 1740s until the 1790s. The beads and coin likely indicate occupation during this second period.

Figure 8.64: The silver half-real coin from Unit 19. (Left) reverse and (Right) obverse.

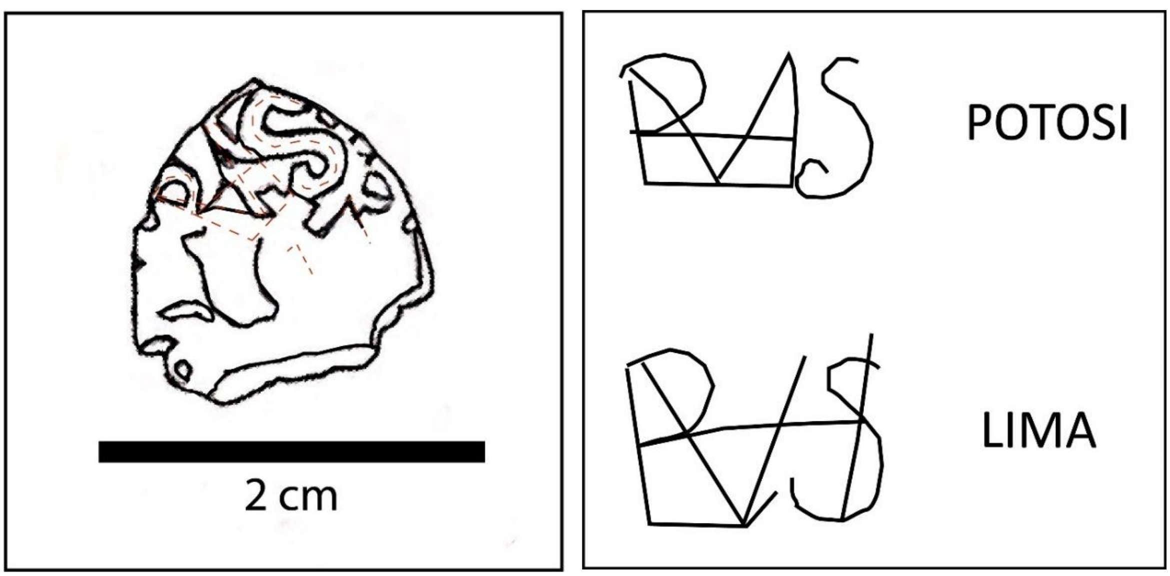

Figure 8.65: (Left) Drawing of the obverse side of the half-real coin, and (Right) the monogram of King Phillip V from the Potosí and Lima mints.

8.9.4 **Lead Musket Ball**

One lead musket ball was found at Trapiche in Unit 16, Sector B, within Building 15 (Figure 8.66). It weighed 20.95 grams and was 14 mm by 15 mm in length. It has a spiral mark on it, indicating it was likely from a mold. The lead ball may have been used with an arquebus, a Spanish matchlock musket (sometimes called a hackbut) that was often fired from a support. Building 15 may have been used as a storehouse for precious metals such as silver and mercury, and the lead musket ball is a remnant of the type of weapon used to guard these materials. Building 15 may also have been a general storage building, and was used to store musket balls and weapons, as well as tools for the refining process.

Figure 8.66: Lead musket ball from Unit 15.

8.9.5 **Tools and Gaming Pieces**

In addition to metallurgical tools, we uncovered a few single-category tools in various sectors of the site. In Sector A, Unit 11 (the laborer house), we found a ceramic spindle whorl used to spin raw wool into useable wool for textile production (Figure 8.67). Textile production was a gendered female activity in the Andes, and women were likely at Trapiche in the capacity of refinery laborers, as well as cooks, servants, wives, and children.

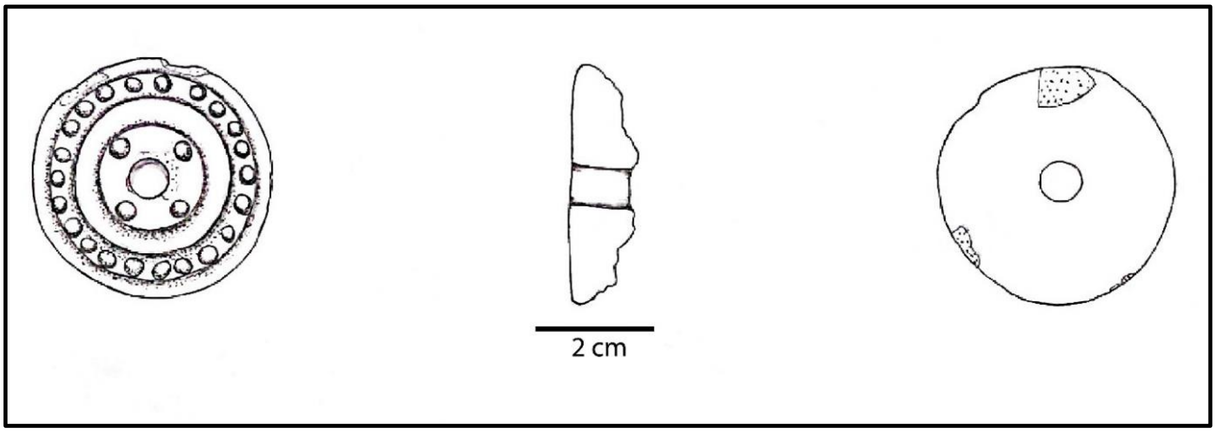

Figure 8.67: Drawing of the spindle whorl found in Unit 11.

Another potential tool was found in excavations in Unit 15, Sector B, Building 13, on top of the living floor (Figure 8.68). This object was made of clay, weighed 4.8 g, and was worked on all four sides, with two holes drilled through the middle of the object. This may have been a type of soldering tool or tube used to blow air and/or control air temperature during the silver refining process. It may have also been used as a whistle. Finally, we uncovered two worked ceramics from Sector C, Units 23 and 24, that may have been used as polishers or as gaming pieces (Figure 8.69).

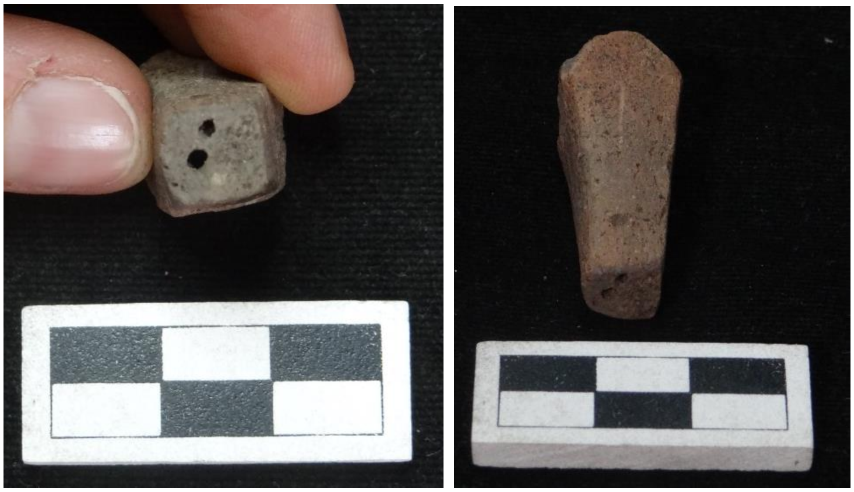

Figure 8.68: Images of a ceramic artifact, potentially a whistle or soldering tool, from Unit 15.

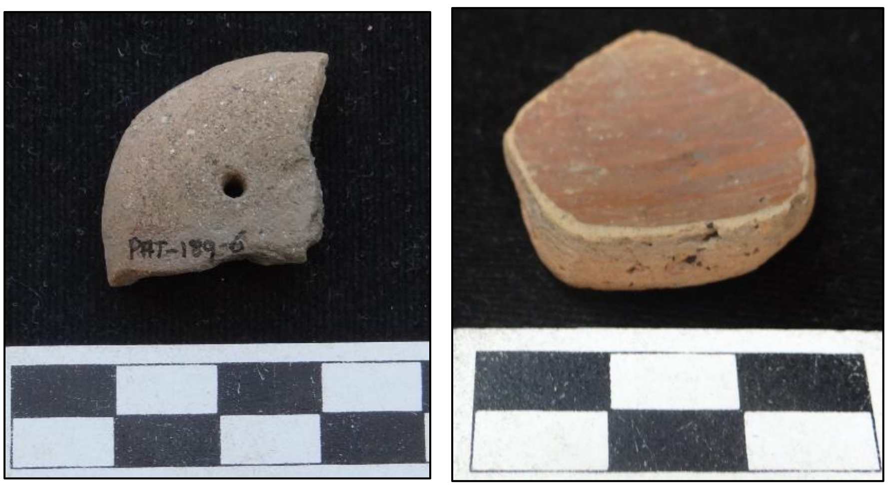

Figure 8.69: (Left) worked ceramic from Unit 23, and (Right) worked ceramic from Unit 24.

8.10 Radiocarbon Dating Results

Historical sources document that the first attempt at colonial silver mining in Puno occurred in the 1650s. The subsequent Laicacota Rebellion over the control of mine resources occurred between 1665-1668. By the 1670s and 1680s, Laicacota silver mine operations were halted due to infrequent maintenance, resulting in mine flooding (Cañete y Dominguez 1952 [1791]:650; Galaor et al. 1998:134). The Puno Bay saw a second resurgence in silver mining in 1744 at the Cancharani mine adjacent to Laicacota, which lasted until the end of the 18th century. Further mining ventures continued in the area throughout the 19th century (see Chapters 3 and 4 for more detail).

Radiocarbon dating was undertaken to evaluate these known historical dates. It was also used to examine the use and reuse of silver refineries throughout time. While there are inherent problems with radiocarbon dating methods for historic archaeological sites occupied in the 17th and 18th centuries (folding of the calibration curve, dates with multiple intercepts and varying probabilities, atmosphere variation due to the industrial era's effect on 14C), plotting dates in sequence using Bayesian statistics correlated to stratigraphy and datable artifacts has been shown to produce tight chronological control. In my case, I recovered artifacts with independent date ranges (i.e., an 18th century raspberry bead; a 18th century Spanish silver cob coin) (Deagan 1987).

The results of the radiocarbon analysis are presented in Figure 8.70 and Table 8.15. Five samples in total were analyzed, from each of the three sectors. Their context, radiocarbon date, and calibrated date are presented with a 2-sigma confidence level of 95% (bolded proportions are the highest, and thus the more likely date range). Full laboratory results are in Appendix F. Dates after 1850 should be ignored, as they are likely due to fluctuations in the 14C content in the atmosphere after 1650, where 14C dates from 1700, 1850, and 1920 are indistinguishable from each other. We found no evidence of glass or any other 19th and 20th century artifacts at the site.

The two earliest dates (B1 and C1) come from the deepest floor levels in Sectors B and C. The deeper sample from Sector A was unable to be analyzed due to small sample size, so I am unable to determine the earliest date for that sector. In Sector B, the dates came from Unit 19 within Structure 24, the house of the owner/overseer. The earliest date, B1, was taken from below the lower dirt floor and is most likely from 1488-1604 AD (2-sigma =0.76). In Sector C, the dates come from Unit 21, within Structure 27, the possible chapel. The earliest date, C1, was also taken below the deepest, original floor and is most likely from 1513-1600 AD (2-sigma=0.742).

While both early date ranges are relatively large (116 years and 87 years, respectively), they put earliest occupation of Trapiche right around the end of the Inka Empire and a few decades into the early Spanish colonial occupation of the Andes (1533-1600 AD). Interestingly, the earliest date ranges end 50 years *before* the Laicacota mining boom of 1650. This means that mining exploration started earlier in the Puno Bay than previous thought. This confirms my architectural and archival research presented in Chapter 4, where I highlight the construction of silver refineries in the Puno Bay many decades *prior* to the Laicacota mining boom.

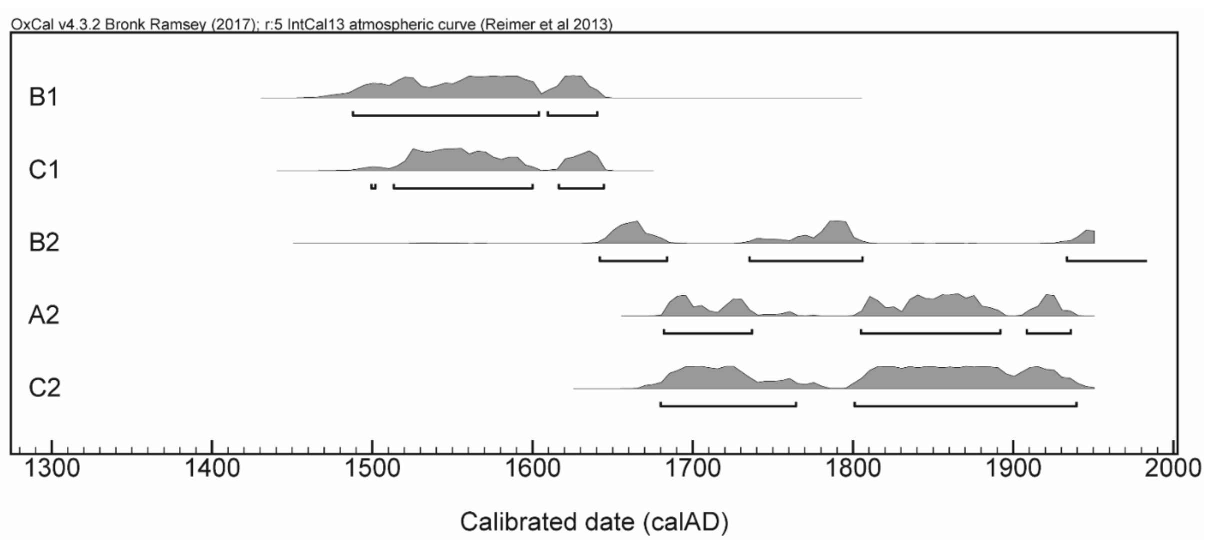

Figure 8.70: Calibrated radiocarbon date ranges from 5 samples at Trapiche.

Table 8.15: Radiocarbon Dates.

Sample ID	Sector	Recinto	Locus	Unit	Cuad	Context	^{14}C age (BP)[21]	CalAD	2σ (95%)
B1	B	Recinto 24	16	19	-	Deep floor in overseer house	330 ± 20	**1488-1604**	**0.760**
								1609-1640	0.194
C1	C	Recinto 27	167	21	1	Deep floor in chapel	315 ± 15	1499-1502	0.005
								1513-1600	**0.742**
								1616-1644	0.207
B2	B	Recinto 24	14	19	-	Midden in overseer house	220 ± 30	1642-1684	0.367
								1735-1806	**0.447**
								1933- present	0.140
A2	A	Recinto 5	74	11	-	Surface burning in laborer house	125 ± 15	1683-1737	0.271
								1805-1892	**0.544**
								1908-1936	0.139
C2	C	Recinto 27	154	21	1	Surface burning in chapel	110 ± 35	1680-1764	0.314
								1801-1939	**0.640**

Alternatively, the location for Trapiche may have been chosen because it sits next to the Inka Road and the area may have been occupied during the late decades of Inka control in the region during the Late Horizon Period. To date, no excavation data has provided evidence for earlier Inka houses at Trapiche, and Inka-like pottery makes up a very small percentage of the overall ceramic assemblage. This lends more support to the likelihood that the first occupation of Trapiche was around the end of the 16th century. A final hypothesis is that very early colonial Catholic religious structures, such as *doctrinas* or *capillas*, may have been built at Trapiche around the 1540s and 1550s. This might explain the various occupations in Building 27, the possible chapel. Silver refining entrepreneurs may have then added to the site in the early 1600s.

[21] 14C dates were calibrated based on IntCal13 atmospheric curve using OxCal 4.3, at 2-sigma range (95%).

The middle date (B2), again from Unit 19, Sector B, comes from a trash midden on top of the occupational floor of Structure 24. It is closer to the surface than the previous date from Sector B, and likely represents a later period of occupation of the building (potentially trash that was never fully cleaned). B2's date range is less secure, and it is hard to determine which range is most likely. The highest probability range (2-sigma=0.447) dates to an 18th century occupation between 1735-1806 AD. The second date range is slightly earlier in time, during a period of 40 years, from 1642-1684 (2-sigma=0.367). Neither date has a high 2-sigma proportion, so it is difficult to ascertain the exact date range. The B2 sample falls somewhere between 1642-1806. This period is consistent with both silver booms in the Puno Bay (1660s and 1720s).

The final two later dates (A2 and C2) come from burnt wood located in the most recent cultural levels in Sectors A and C (directly below the surface). The A2 sample was taken inside Unit 11, Structure 5, the house of a laborer. This is the same structure where we uncovered beads, a clay spindle whorl, a broken llama figurine, a stone floor, and hearth. Three date ranges were applied to this date, although the highest 2-sigma value (0.544) was for the period between 1805-1892. The second highest 2-sigma value (0.271) was for the period of 1683-1737. It is likely that the last occupation of Trapiche, whether this was some ad-hoc smelting, or intentional burning and clearing of land, occurred during the 19th century, sometime between 1805-1892.

Sample C2 (Unit 21, Sector C) was from a similar sub-surface burning event, and the 2-sigma range (0.640) for this sample was between the period of 1801-1939. The date range for this burning event is very large, and it is hard to determine when it occurred over a space of 138 years. However, because Trapiche lacks any 19th and 20th century material remains, these events do not seem to document long-term occupation of the site during these centuries. Instead, occupation of

Trapiche likely ended sometime before 1850. Burning events close to the surface of these units likely reveals 19th and 20th century land clearing strategies (strategies that continue today).

8.11 Summary

This chapter presented data from artifact analysis of 2018 excavation materials from Trapiche. Summaries of general data patterns include: faunal remains; macro-botanicals; lithics; metals; ceramics; special objects; and radiocarbon samples.

Diagnostic artifacts and radiocarbon analyses put the occupation of Trapiche between 1488-1850 AD, with at least two phases of occupation: early and late. Early occupation of Trapiche likely began after the fall of the Inka Empire, sometime between 1570 and 1600. This period of site-use likely lasted until the 1680s and 1690s, when a silver bust hit the Puno Bay. The second, late period of occupation likely occurred at Trapiche between 1700-1850, during the 2nd boom of silver mining at the Cancharani mine. We did not find glass or any other artifact indicative of Republican Era occupation, and so it is very unlikely Trapiche was occupied after 1850 AD.

Artifact analysis of plant and animal remains point to a more diverse array of foodstuffs in Sector C surrounding the chapel, and less variety in Sector A, surrounding the laborer households. However, access to high quality cuts of meat was common across all sectors of Trapiche. Additionally, laborers and other site residents tended to eat a very typically Andean diet, high in camelid meat and quinoa served as soups and stews and flavored with chile peppers.

Metal use was rare at Trapiche, and metal nails and door hinges were likely only used in restricted areas. Lithic tools, including grinding stones and chipped stone tools, were used across the site, and it is likely laborers continued their local, Andean stone tool traditions well into the middle and late colonial period at Trapiche.

The majority of ceramics at Trapiche were local in their style and construction and were made in the western Lake Titicaca Basin, possibly in Puno and Chucuito. The few Inka-like and colonial style ceramics found at the site tend to cluster in areas of higher status, such as Sector C. There were more serving wares than cooking wares at Trapiche, especially in Sector A where the laborer houses are located. This indicates less control over direct provisioning and preparing of meals, revealing a centralized provisioning system for the site.

9.0 Discussion and Interpretations

9.1 Introduction

This chapter uses spatial and statistical analyses to discuss intrasite patterns of labor, foodways, provisioning, and control at Trapiche Itapalluni. Using 2018 excavation and artifact analysis data, this chapter examines broader site- and regional-level patterns. This chapter begins with a multivariate analysis of a combination of variables across Trapiche's 2018 excavation units. These techniques are used to locate activity areas at the site, as well as to better understand how some artifacts and areas were restricted and/or utilized in controlled manners.

Following the presentation of the multivariate analyses, this chapter widens to discuss larger patterns and themes of the data. Site-level patterns are represented in a series of site maps for easy visualization. The remainder of this chapter discusses the implications of the results, returning to the research questions and tying the results back to larger, societal questions of daily life in colonial Peru. There is a discussion of living conditions for workers, highlighting levels of surveillance and control within the site. Status, privilege, and prestige is also discussed. These data highlight themes of identity, social mobility, and overall wellbeing for individuals working in the silver refining industry in 17^{th} and 18^{th} century Peru.

9.2 Multivariate Analyses Across Units

Multivariate analyses using ordinal, interval, and ratio variables (ranks and real measurements) from all 20 excavation units revealed several intrasite spatial patterns at Trapiche. I conducted multidimensional scaling (MDS), principal components analysis (PCA), and hierarchical cluster analysis (HCA) to measure similarities between excavation units and their artifact categories, examining activity areas, craft specialization, foodways, and living conditions across Trapiche.

9.2.1 **Multidimensional Scaling (MDS)**

Multidimensional scaling (MDS) analysis examined 20 variables across all 20 excavation units (see Appendix G for the MDS variable dataset, coding key, matrix, and stress level calculations). I used Gower's Coefficient (a mixed variable coefficient) to determine similarity scores between the 20 units. Using a mixed variable coefficient was necessary because the variables included categorical (house quality), presence/absence (exotic and high-status goods), and measurement data (sherd density, artifact count). A matrix of similarity scores was generated using SIMS, and stress levels were calculated at 1, 2, 3, 4, and 5 dimensions. The declining stress values indicated MDS stress values leveled off at two dimensions at 0.119. Using two dimensions, I generated 20 scatter plots using x/y coordinates, representing the clustering of similar excavation units. Each variable was inputted as a z value, and all scatter plots can be found in Appendix G.

Following the production of MDS scatter plots, patterns in the data became visible. House quality rank (1 as best, 3 as worst), defined by masonry and overall size, revealed three distinct groups of units. The presence of plaster was a strong distinguishing variable, which correlated with the total count of niches per structure. In Figure 9.1, these three variables are plotted together for easier visualization. Plaster and niche count were strong predictors of house quality, and together with the size of the structure, signal better living conditions. Lower status housing form similar clusters in units from Sector A, identified as temporary laborer houses. The MDS analysis confirms the probable use of these structures as lower-quality households.

MDS also revealed further correlations between house quality and artifact type. Units with higher proportions of serving ceramics were more similar to units in lower-quality houses (Figure 9.2). Units 7, 9, and 10 had much higher proportions of serving ceramics than other units at Trapiche. Units 9 and 10 were located in Sector A among the laborer households. Unit 7 was located in the work patio of Sector B and its count of serving sherds is somewhat misleading and inflated, as only seven total ceramics were recovered from this unit.

The strong relationship between lower status households and serving vessels strengthens the hypothesis that Trapiche laborers had less direct control over their cooking. MDS also shows laborer houses had few storage vessels, in addition to few cooking vessels (cooking sherds). High amounts of serving wares within these houses suggest consumption was the most frequent activity occurring in these structures. Laborers were likely given provisions or were served already cooked meals. They may have been given these meals from a stock supply of serving plates and bowls.

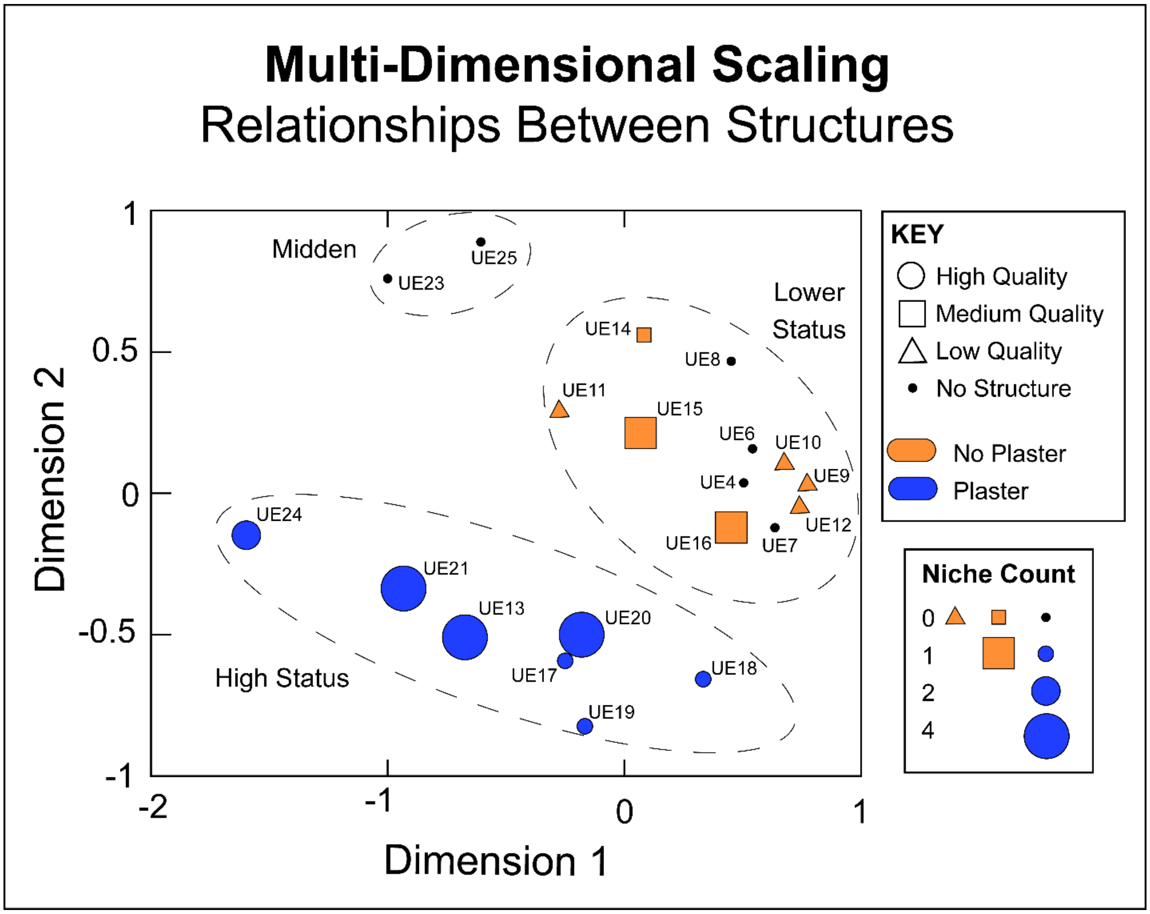

Figure 9.1: MDS scatter plot depicting house quality rank in conjunction with presence of plaster and total niche count/structure.

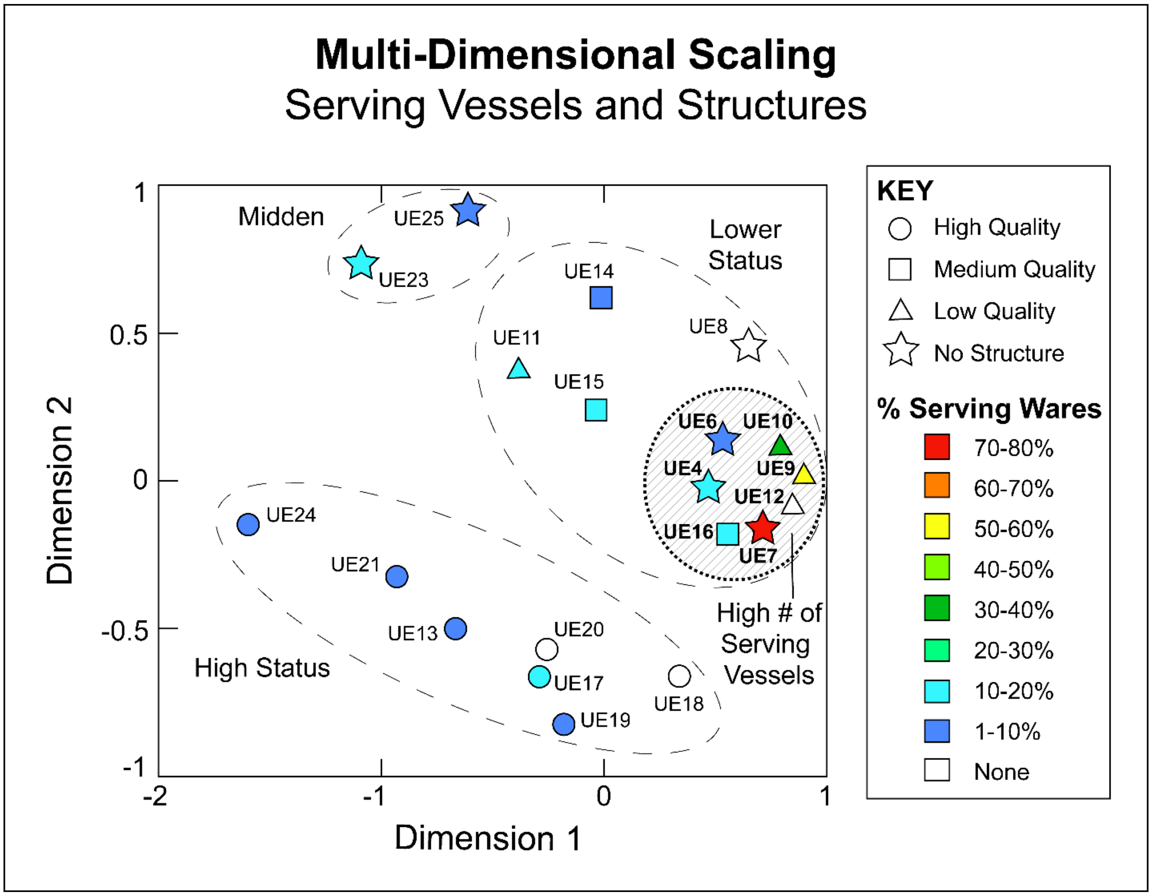

Figure 9.2: MDS scatter plot depicting house quality in comparison with percent of serving wares.

MDS analysis also revealed strong intrasite patterns of ceramic style, type, and function. In Figure 9.3, ceramic variables *other* than serving wares were plotted against each other. Two separate clusters of units with high proportions of storage vessels were formed (Units 14 and 18, and Units 13 and 21), as well as one cluster of units with high proportions of cooking ceramics (Units 15 and 19). Until MDS was performed, the location of cooking spaces at Trapiche were difficult to determine. Both Units 15 and 19 are in Sector B, away from the laborer households (Figure 9.4). Unit 19 is hypothesized to be the household of a higher-status individual, possibly the overseer/owner, and likely had more control over individual cooking and provisioning. The high proportion of cooking wares in Unit 19 supports this hypothesis. Unit 15, however, has been difficult to characterize until this point. Unit 15 may have been another area of food preparation and distribution at the site, as it is in the administrative area with higher surveillance.

Another trend in the ceramic MDS patterning was the high proportion of Inka-like wares and *botijas* (Spanish olive jars) in Unit 24. Unit 24 is located in Sector C in a small building with two niches just off the chapel. This unit has been hypothesized as a caretaker's house, a storage area for chapel goods, and/or the residence of a priest. This building would have been an important place to store provisions related to the church, which may explain the high number of *botijas* (possibly to store wine, grapes, olives, and water). The high proportion of Inka-like ceramics is also noteworthy, as very few Inka-like ceramics were found at Trapiche.

The presence of Inka-like sherds does not mean that Unit 24 was occupied prior to the Spanish arrival. The Inka-like sherds are not diagnostically imperial Inka but likely a locally made, high-quality "look alike" that was produced throughout the 16th – 18th centuries. Unit 24's high proportion of these fine-ware vessels may instead suggest elevated wealth or status (given the high quality), or a local ethnic affinity.

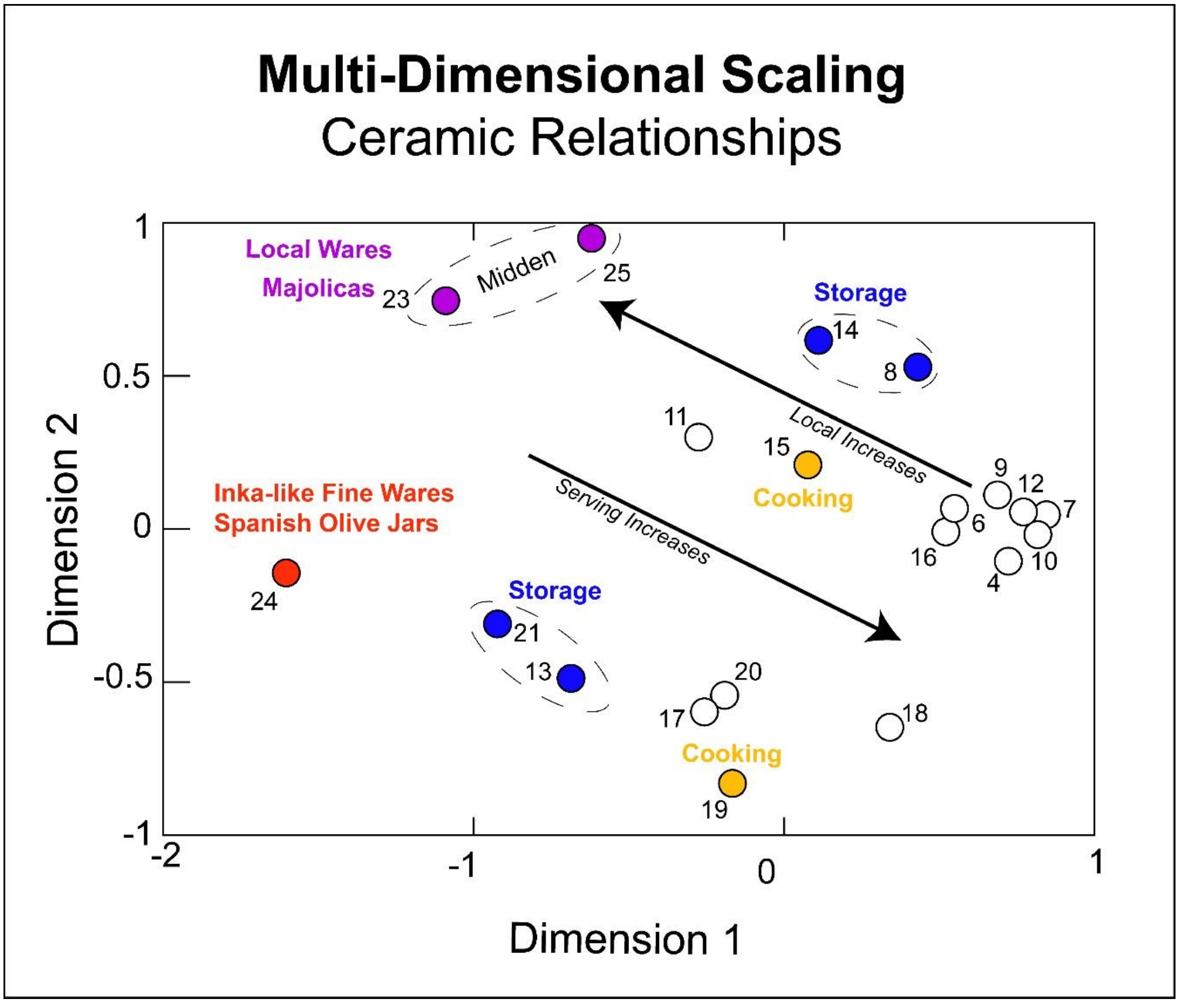

Figure 9.3: MDS of ceramic patterns at Trapiche.

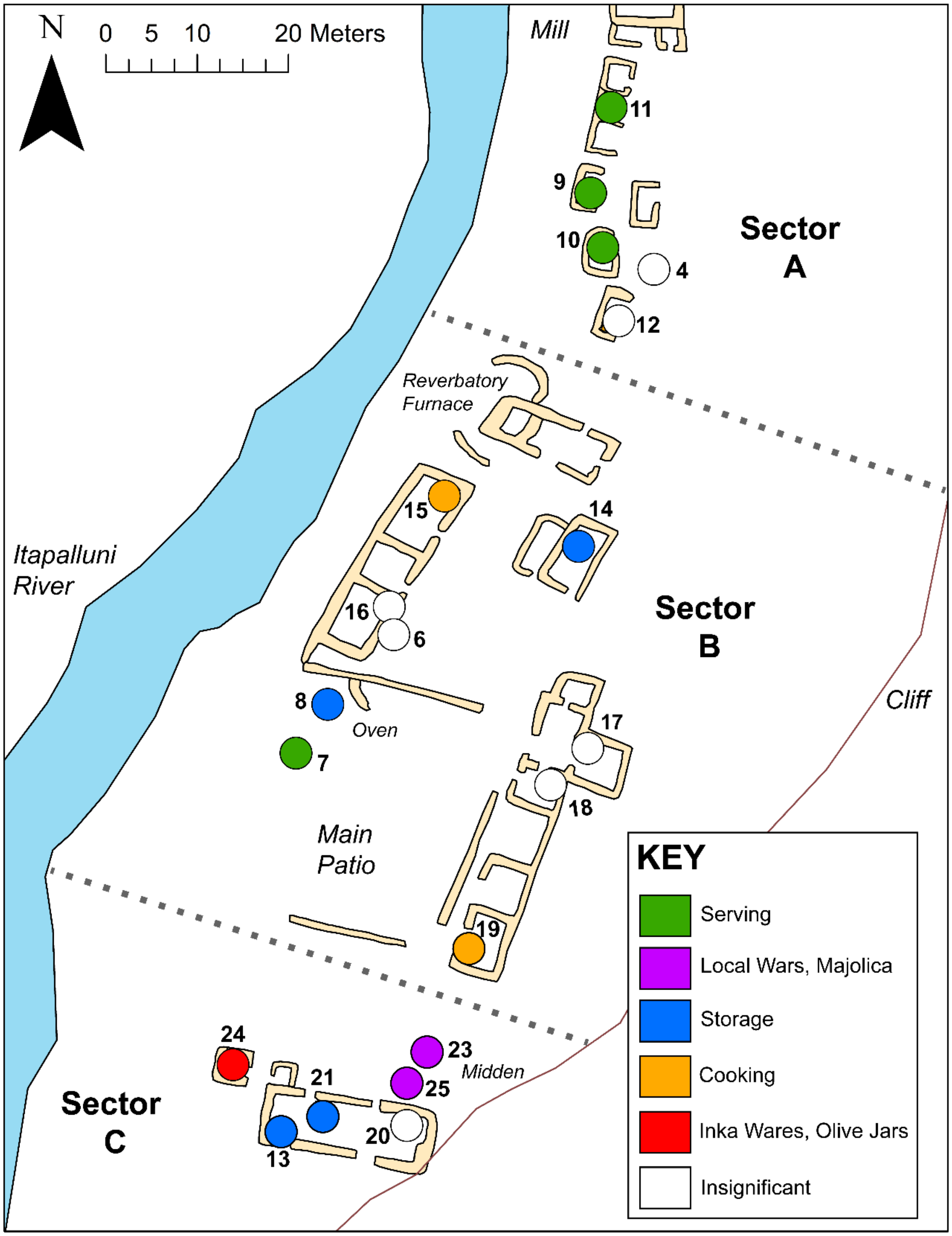

Figure 9.4: Spatial representation of MDS ceramic patterning at Trapiche, highlighting units that grouped together due to specific variables.

The final significant pattern revealed during MDS was the cluster of Units 8 and 14 with a high proportion of storage and mercury ceramics pots (Figure 9.5). The high percentage of mercury pots allude to silver refining tasks near these units, such as mercury amalgamation.

MDS revealed strong similarities between units in high-quality households, including structures with plaster floors and walls, and wall niches for additional storage. MDS also revealed similarities across units with high proportion of serving, storage, and cooking ceramics. Sector A structures had higher proportions of serving wares, while two units in Sector B had higher proportions of cooking wares. Sector A households were likely those of Trapiche laborers, while Sector B was an administrative area. Cooking and food preparation appear to have been undertaken in controlled and easily surveilled locations. Mercury amalgamation and reuptake occurred in Sector B in Units 8 and 14.

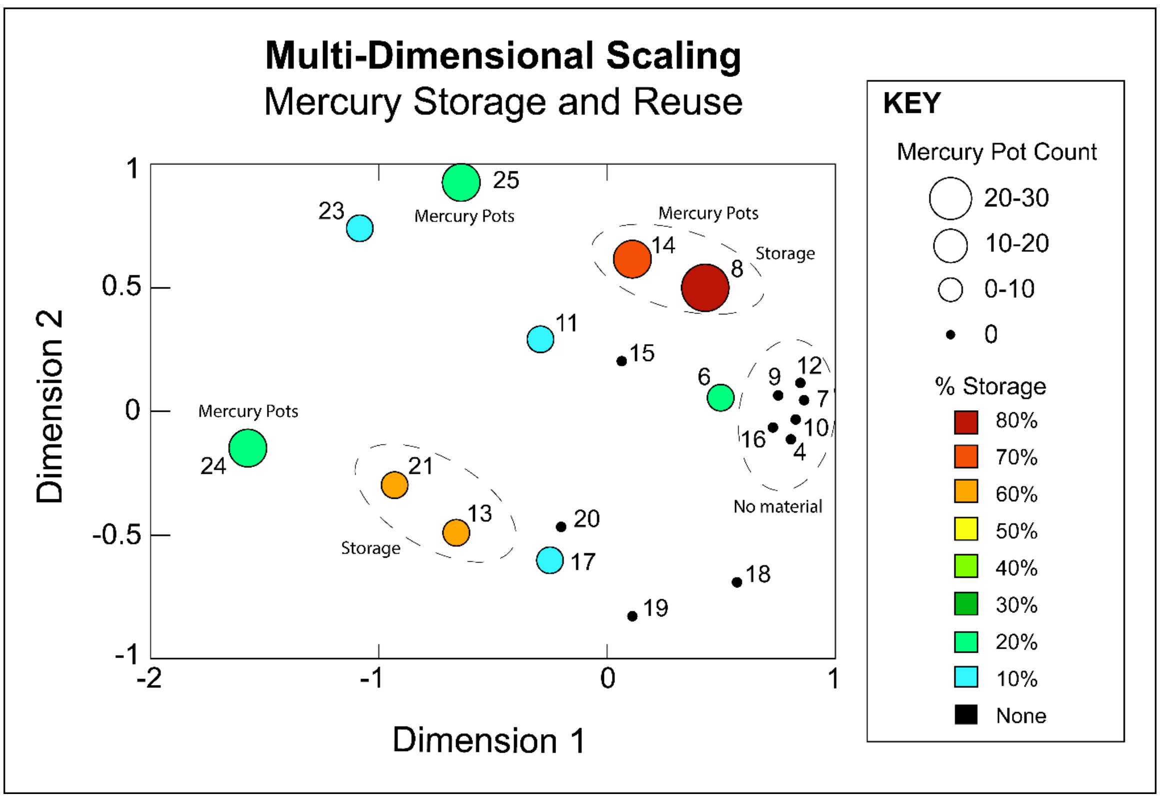

Figure 9.5: MDS representing count of mercury pots at Trapiche compared with percentage of storage vessels in each unit.

9.2.2 **Principal Components Analysis (PCA)**

Principal components analysis (PCA) examined 17 variables across 20 excavation units (Appendix G). Three variables were left out of PCA that were included in MDS (presence of majolica, olive jars, and exotic objects) to avoid redundancy with count variables. Following the Kaiser Rule, all components with eigenvalues greater than one were extracted, and six components met these criteria (Appendix G). No one component explained more than 20% of the variance between the 17 variables. Thus, multiple factors played a role in the distribution of variables across Trapiche. The first three components contributed to a total of 50.7% of the total variance and are depicted in two scatter plots (Figures 9.6 and 9.7). All six component loadings and their variance are listed in Appendix G.

Component 1 is characterized by a strong, positive correlation between sherd density, majolica count, and local sherd count, and explained 20.7% of the total variance. The grouping of these three variables onto Component 1 suggests that ceramic density, including Spanish majolica and locally produced pottery, was the main distinguishing variable between the 20 excavation units. Ceramic density is often used as an indicator of human occupational density, and high sherd density at Trapiche likely indicates high-use activity areas, such as living quarters, middens, and work areas. The lack of ceramic sherds in certain units and areas indicates less of these activities.

Component 2 is characterized by a strong, positive correlation between niche count and presence of plaster and explained 15.5% of the variance. This grouping highlights the connection between buildings with plaster walls and floors and buildings with niches, indicating these structures were higher status, with more effort going into building and decorating them.

Component 3 is characterized by a strong, positive correlation between mercury pots and storage ceramics, as well as a strong, negative correlation with serving ceramics (14.3% of the variance). This indicates that activity areas of Trapiche where laborers ate meals on serving plates and bowls were very separate from areas of mercury amalgamation and storage. It also indicates that laborers were not storing goods within the structures they consumed their meals, nor were they allowed to be near stored materials. This indicates that storage of goods and supplies was somewhat restricted and controlled at Trapiche.

Component 4 is characterized by a strong, positive correlation between Spanish olive jars (*botijas*) and Inka-like ceramics and explained 14.9% of the variance. This pairing of variables is interesting, as olive jars are a foreign, Spanish-style storage container made in the 16th – 18th centuries, while Inka-like ceramics mimic local Imperial wares. Both Inka-like ceramics and olive jars do not correlate with local-style ceramics, which are the most prevalent ceramic style at Trapiche. Inka-like ceramics and olive jars may represent higher-status wares, or wares used for specific, restricted purposes, such as the storage of important goods.

Spanish majolica does not correlate with Spanish olive jars at Trapiche. This pattern likely represents behavioral differences in the use of majolica within the Trapiche silver refinery, as majolica wares tend to be used as serving plates and bowls. These results indicate majolica may not have been a status or restricted item at Trapiche.

Component 5 is characterized by strong, positive value for the presence of specialty tools (musket ball, spindle whorls) and represents 7.9% of the total variance. Component 6 is characterized by a strong, positive value for the number of cooking ceramics and represents 8.9% of the total variance. These final two components indicate that the presence of specialty tools, as well as cooking ceramics, were unique variables, and did not pattern well with other variables at Trapiche. This indicates that specialty craft activities (such as textile production) and cooking were concentrated in specific areas of Trapiche, strengthening the argument that cooking and provisioning were centralized at Trapiche.

PCA confirmed many patterns already observed in the MDS. PCA confirmed the relationship between house quality and serving wares, the relationship between plaster and niche count, and the relationship between Inka-like wares and olive jars. PCA analyzed both positive *and* negative correlations between Trapiche variables, and revealed a strong, positive correlation between mercury pots and storage ceramics, as well as a strong, *negative* correlation between these two variables and serving ceramics. This negative correlation revealed that areas of Trapiche where food was served to laborers were separate from activities related to mercury amalgamation and storage.

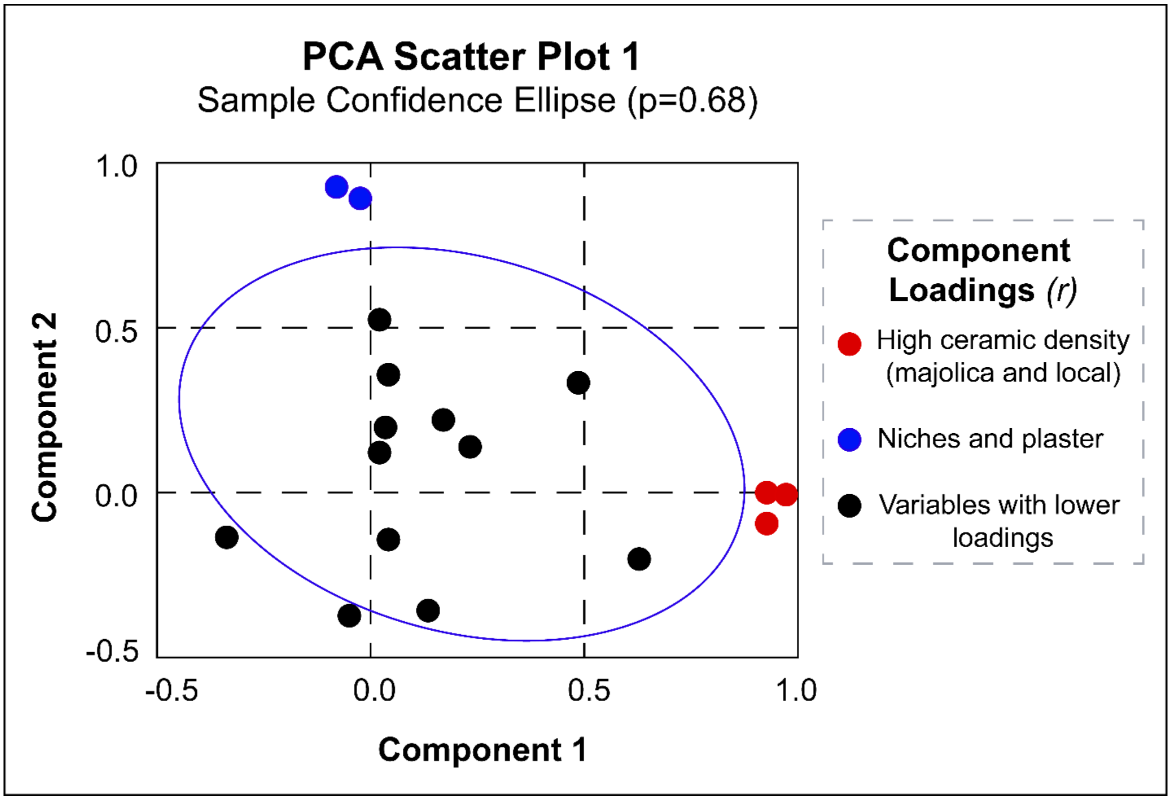

Figure 9.6: PCA scatter plot of component loadings, component 1 vs component 2.

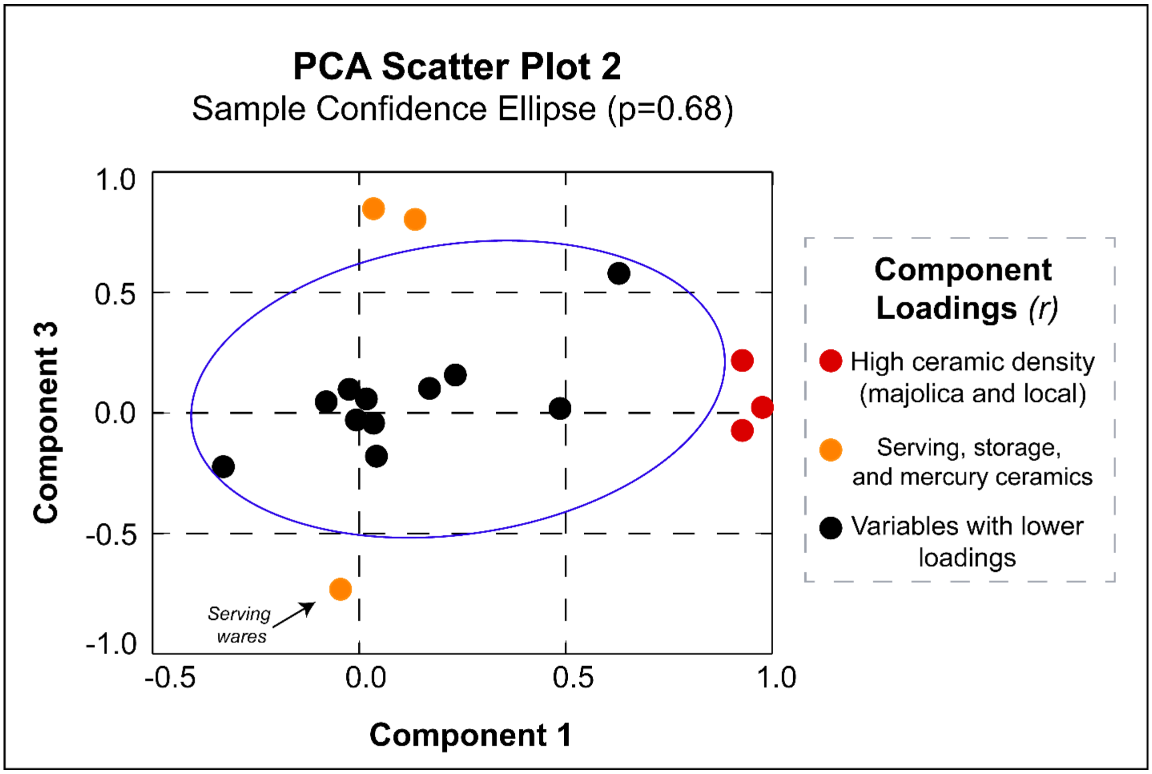

Figure 9.7: PCA scatter plot, component 1 vs. component 3.

9.2.3 **Hierarchical Cluster Analysis (HCA)**

Hierarchical cluster analysis (HCA) examined the same 20 variables that were used in the MDS analysis (Appendix G). HCA conducted for "cases" (excavation units) used the MDS matrix of similarity scores. The matrix was standardized prior to HCA analysis. HCA analysis by cases used Euclidean distance and complete linkage. HCA by variables used Pearson's *r* and both average *and* complete linkage. Complete linkage prevented clusters with dissimilar members, while average linkage allowed for a new matrix of similarities after each join. Both provided slightly different interpretations.

HCA by cases revealed six groupings of units by their similarity scores, shown in the dendrogram (Figure 9.8). The groupings are represented visually on the site map in Figure 9.9. The two units that made up the first cluster were Units 8 and 14 (in blue). As discussed previously, both are related to silver refining practices, as each unit had large quantities of mercury pots. Units 8 and 14 are the two main refinery work areas that were excavated in 2018. Other areas related to silver refining, such as the reverberatory furnace and the mill, were not excavated.

Eight units formed the second cluster (Units 4, 6, 7, 9, 10, 12, 15, and 16) and their similarities are likely due to the low level of material found within them (in orange). While some of these units were likely storage buildings, Units 9, 10, and 12 likely served as both storage *and* housing for laborers at the refinery, as local serving wares were uncovered in these three units.

The final four clusters joined at similar distances and included: tool use (Units 11, 17, and 20, green); higher-status administrative and domestic activities (Units 18 and 19, purple); higher-status ecclesiastical activities (Units 13, 21, and 24, red); and trash disposal (Units 23 and 25, light blue).

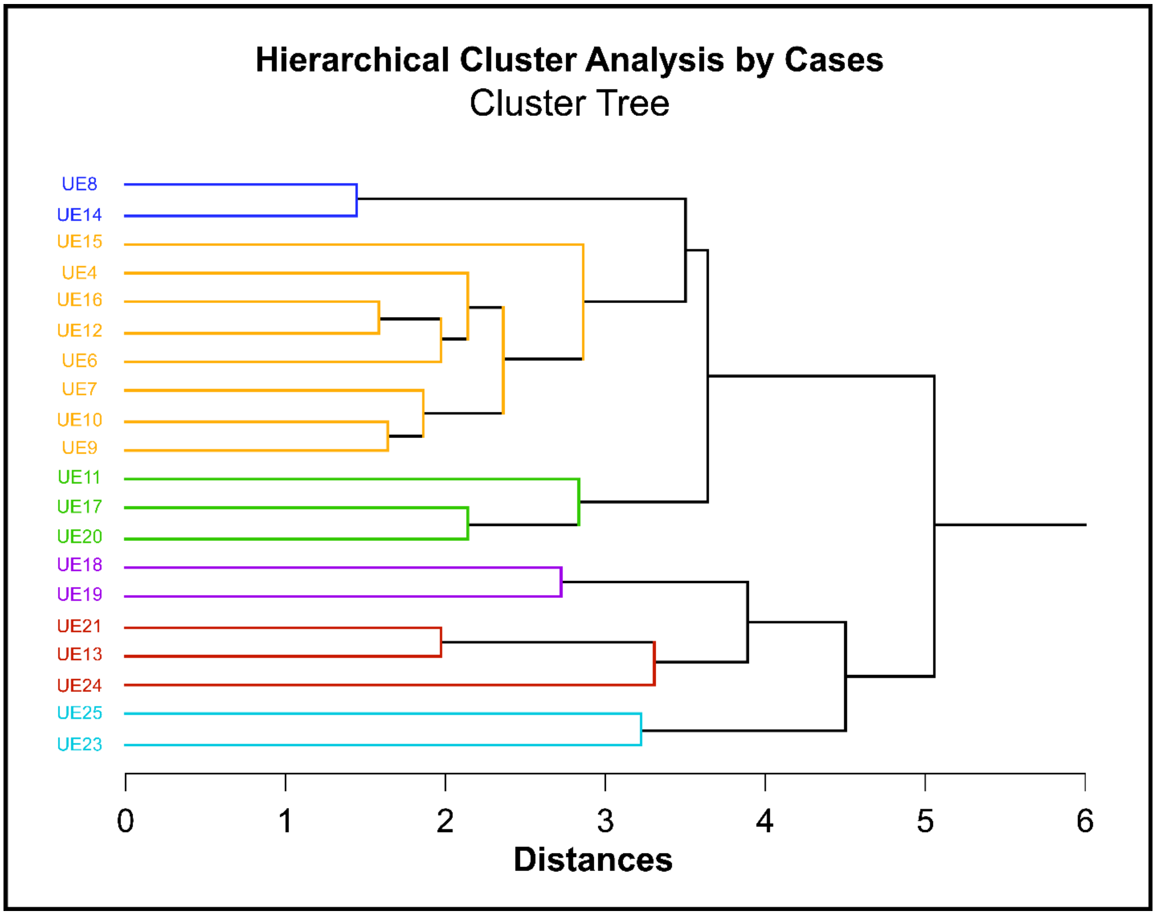

Figure 9.8: HCA by cases using complete linkage, Euclidian distance.

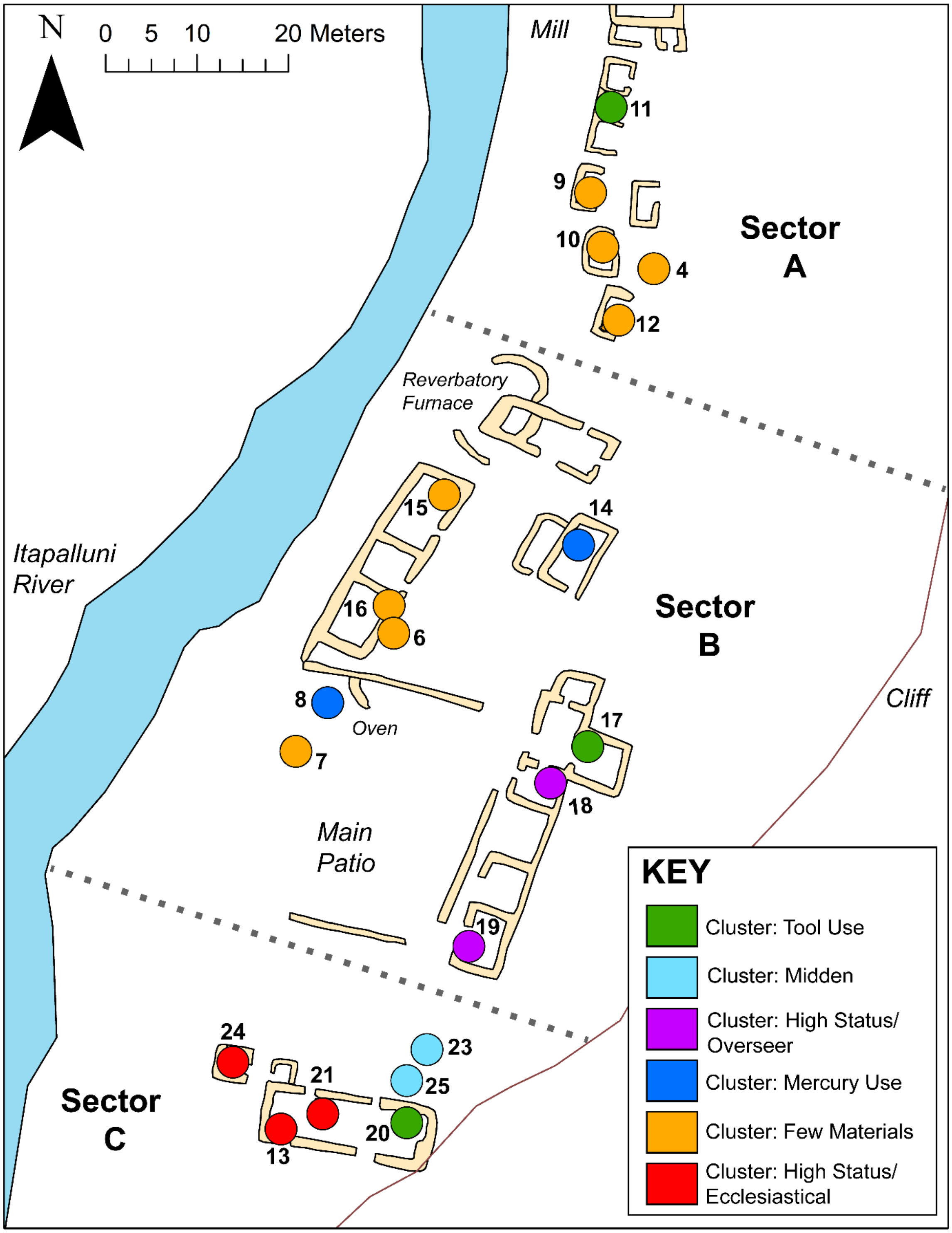

Figure 9.9: Site map of Trapiche excavation units, colored to represent HCA by cases (similarities between units).

Cluster 4 (tool use) was initially difficult to interpret. Unit 11, in Sector A, which was located inside a laborer household with a hearth, cooking and serving ceramics, and lithics tools. Unit 17, in Sector B, was an administrative area. Unit 20, in Sector C, was inside a later-occupation northern addition to the chapel. It is likely these three units “joined” together in a cluster because of their higher proportion of tools, including grinding stones, mercury pot lids, and a possible counting weight. One important take-away from this cluster is that Unit 20 is *more* similar to other areas of Trapiche *outside* of the chapel (Units 11 and 17) than those within it (Units 13 and 21). In other words, the northern portion of the chapel was likely *not* ecclesiastical, supporting the hypothesis that it was a later-period addition to the chapel structure.

HCA by variables was performed using Pearson’s *r* and complete *and* average linkage. HCA with complete linkage’s first cluster contained Inka-style sherds and olive jars (in blue) (Figure 9.10). This pattern was also seen in the MDS and PCA and underscores the strong relationship between these categories. Also joining in this cluster was plaster and niche count. This indicates that these four variables may group together as a higher-status suite of variables.

House rank and serving sherds (in red) also form an early join, revealing a strong correlation between house rank and serving sherds. The lower the quality of the house, the more serving sherds were present. Two additional clusters joined relatively early and correspond to ceramic variables. In one, storage sherds, mercury pots, and colonial sherds cluster together (in orange). This likely represents the use of Spanish colonial ceramic wares in storage activities, as well as in silver refining activities. In the other cluster, local sherds, majolica, and sherd density cluster together (in green). This cluster is most representative of occupational density and high-use areas at Trapiche. Because majolica only joins with local sherds (never on its own), it is likely that majolica was *not* used as a restricted, status symbol at Trapiche. The final cluster includes bones/sherds, status foods, exotic objects, and cooking sherds (in pink). These variables may indicate another suite of higher status variables, with access to status foods, exotic objects, and cooking ceramics.

HCA with average linkage provided a similar interpretation of Trapiche variables (Figure 9.11). The earliest variables to join were Spanish olive jars and Inka-like sherds (in light blue). The only other variable to join their cluster in this analysis was high-status foods, which was different from the complete linkage. This highlights the connection between these ceramic wares and other higher-status variables. The second major cluster to join was the ceramic density cluster and included sherd density, local sherds, and majolica (in blue). This is the same pattern observed in the complete linkage HCA.

The third cluster was the silver refining cluster, including mercury pots, colonial ceramic vessels, and storage wares (in orange, again the same as complete linkage). The fourth cluster included serving sherds and house rank (in red), highlighting the relationship between quality of house and presence of serving sherds (again the same as complete linkage).

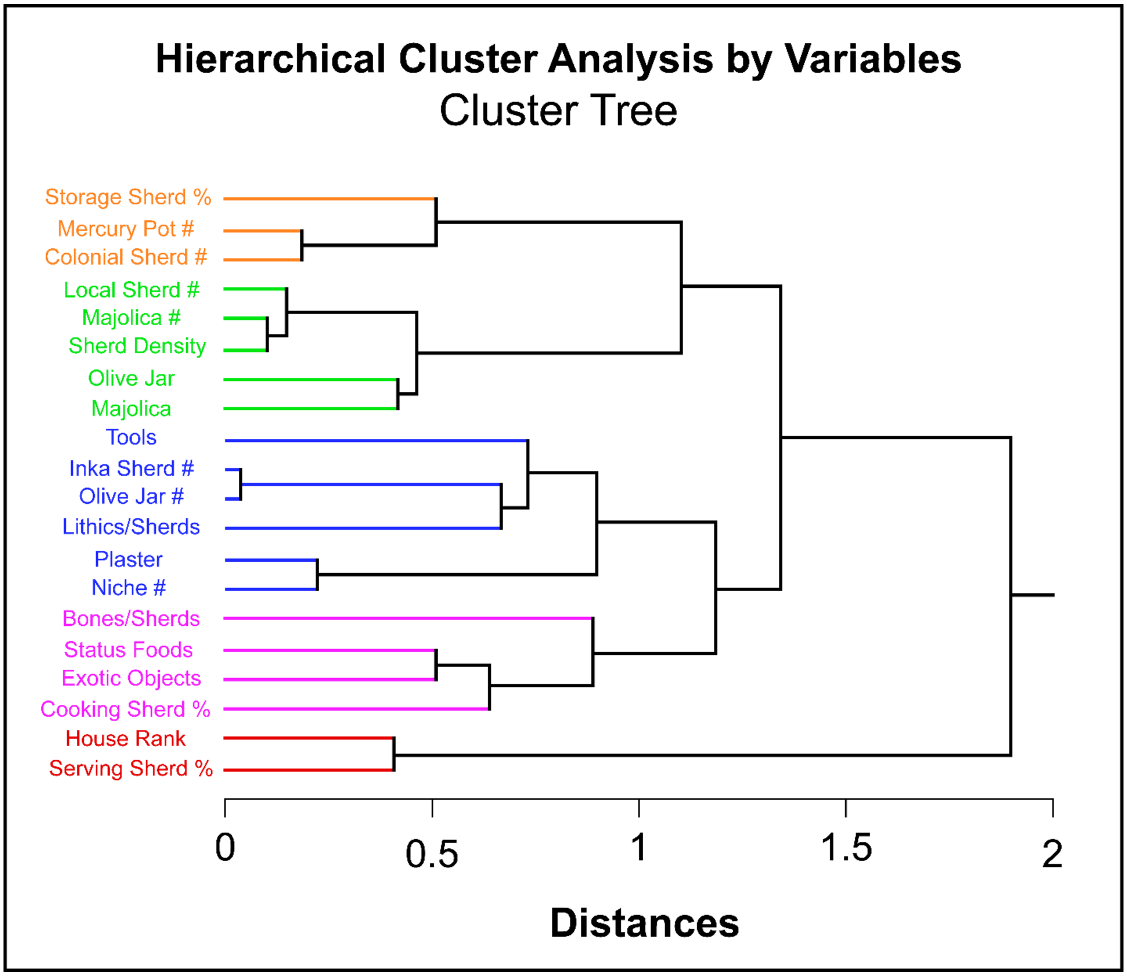

Figure 9.10: HCA by variable. Complete linkage using Pearson's r.

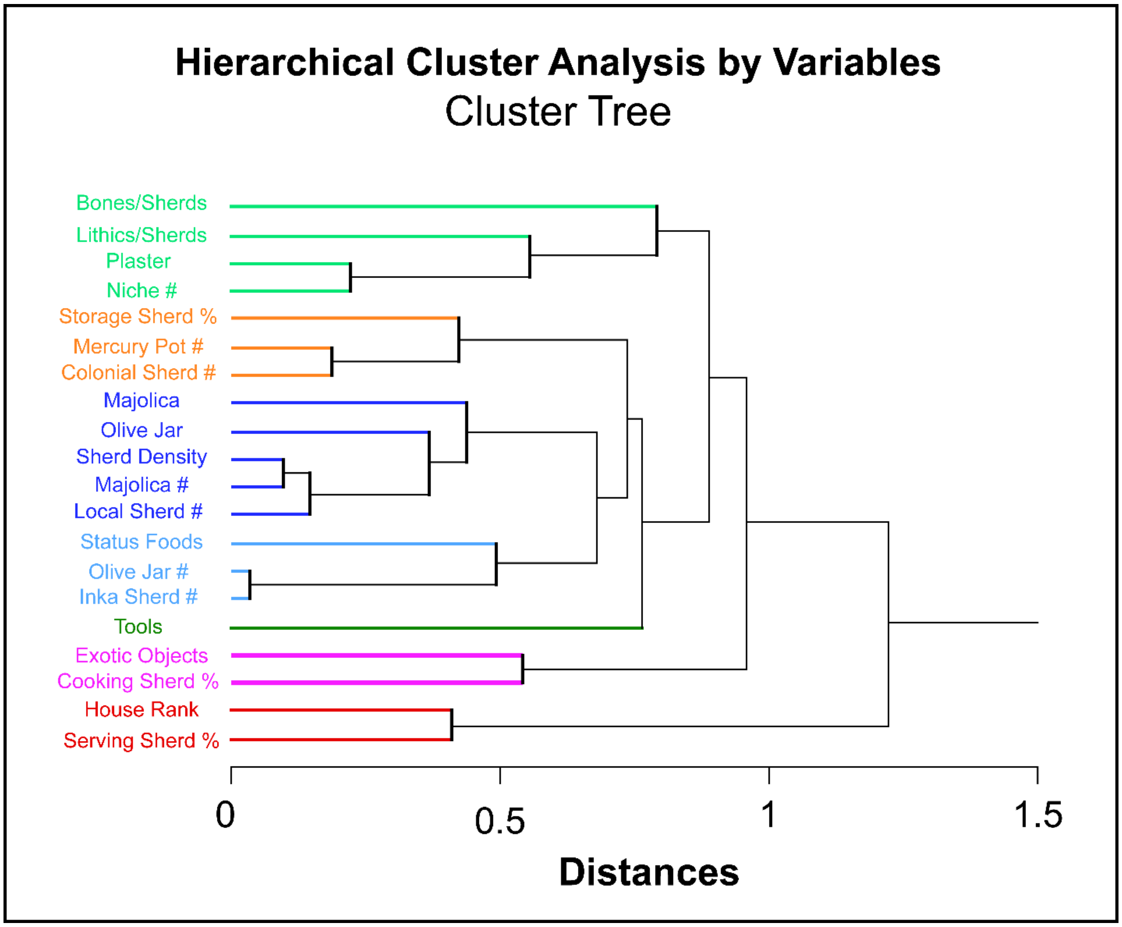

Figure 9.11: HCA by variable. Pearson's r, average linkage.

The final cluster in the average-linkage analysis differed from the complete linkage HCA (light green). This cluster included bones/sherds, lithics/sherds, plaster, and niche count. This may have been another higher status cluster of plaster and niche along with higher proportions of bones and lithics relative to ceramics. This cluster may indicate higher-status control of specialized craft activities done with bones or lithics, or control and surveillance of the storage of important status food items and lithic tools.

HCA conducted for cases (units) revealed six groups of 20 excavation units by similarity score. This included units related to mercury use, high status activities, and tool use. HCA conducted for variables revealed strong clustering of variables related to mercury use, high status activities, low status activities, and craft production. Results reveal control of consumption activities, storage of goods, and craft production.

9.3 Intrasite Analysis of Foodways

The multivariate analysis focused on ceramic patterning at Trapiche and did not examine botanical and faunal remains in detail. Instead, this was done using GIS and chi square analyses. This section will present the results of intrasite foodways patterns, discussing intrasite patterning of faunal remains, botanical remains, and ceramic remains. Most data are described in more detail in Chapter 8 but given better visualization in this chapter. I have included these visuals here in Chapter 9 as broad intrasite patterns are more helpful to understand in the context of the larger discussion of status, control, and identity with the Trapiche silver refinery.

9.3.1 Intrasite Faunal Patterns

The results of the multivariate analysis revealed strong associations between high status meats at Trapiche (guinea pig, pork, and fish) with other higher-status variables such as exotic objects (coins, beads, jewelry), Spanish olive jars, and Inka-like ceramics. High status foods also patterned strongly with cooking sherds, which indicate spaces of self-reliance at Trapiche. These results also reveal some restriction of high-status meats at Trapiche. However, most identified animal meat at Trapiche was not from guinea pigs, swine, or fish. Instead, it was from camelids (NISP=47; MNI=14) and caprids (NISP=40; MNI=4), described in Chapter 8 in more detail.

While residents of Trapiche had access to diverse meats from various sources, camelid meat was what was consumed in the largest amounts, showing a maintenance in native Andean foodways well into the middle and late colonial period. The frequency of remains from these animals also varied across the site and are presented in more detail below.

Faunal results varied spatially at Trapiche (Figures 9.12 – 9.14). Inside the laborer houses, there was a very low richness of animal taxa (3/10) and the units were dominated by artiodactyl meat. However, in Unit 19 (the overseer/owner house), there was a much higher richness of animal taxa, including caprids, cow, and guinea pigs. This increases even more for contexts near the chapel and communal midden, with 10 taxa identified.

Three animal species only found near the chapel were pigs, chicken, and fish. The limited presence of pork is interesting, as pork was a strong indicator of "Spanish-ness" and Catholicism for Iberians in the 17th century, as its consumption was outlawed by both Jewish and Muslim dietary laws (Earle 2012). I have previously argued (Kennedy et al. 2019) that the practice of pork consumption became more restricted in the colonial Andes, as high-status individuals choose to set themselves apart from ordinary eating habits by eating pork. This appears to have also been happening at Trapiche. The presence of fish near the chapel is also in keeping with Catholic dietary practices (Earle 2012). Interestingly, one fish species was local to Lake Titicaca, while the other was a marine fish brought from a considerable distance, likely salted and shipped from the Pacific coast on one of the colonial roads connecting Puno and the highlands to important trading ports.

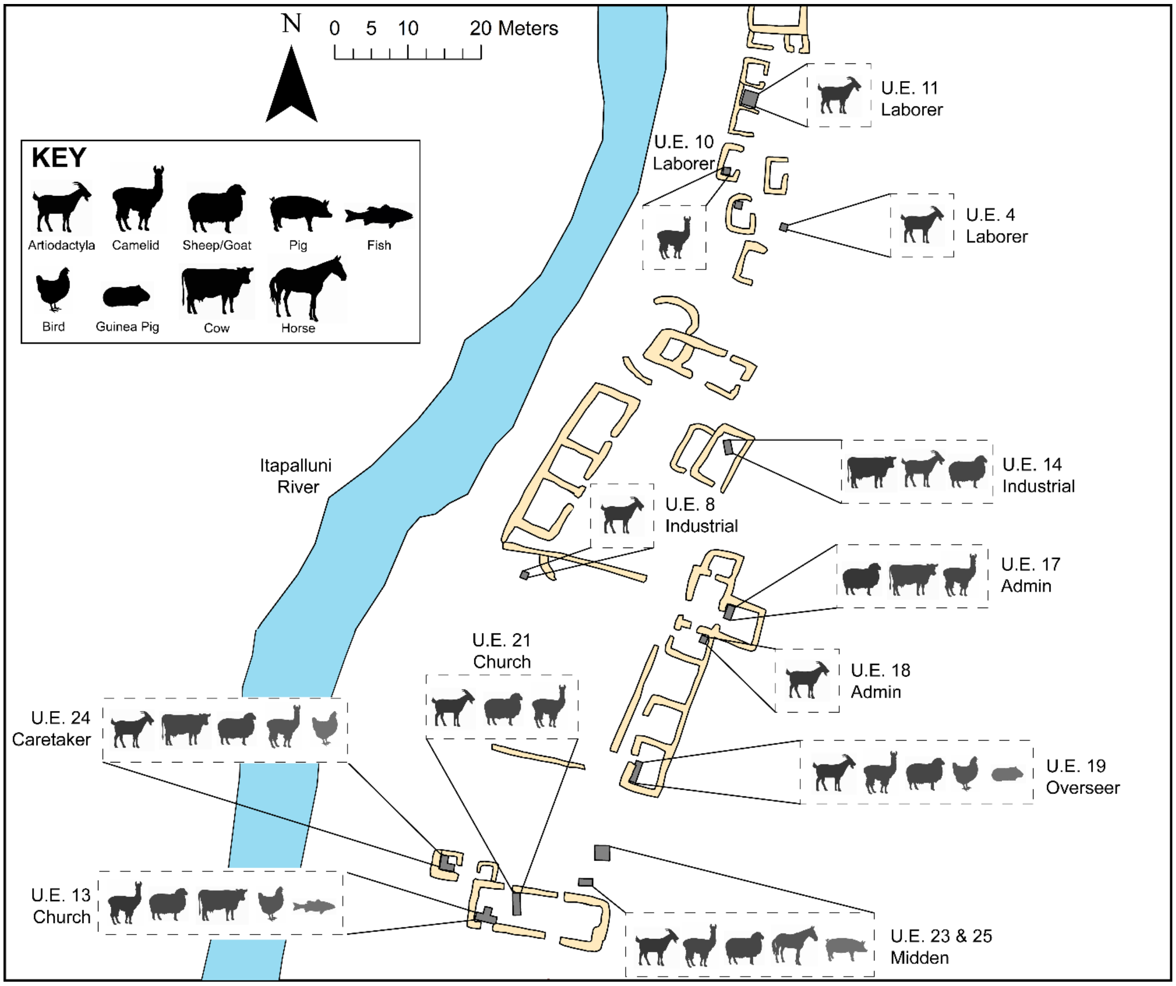

Figure 9.12: Animal taxa by unit at Trapiche. Gradient shading, from left to right, depicts the most prevalent taxa per unit. Left is most prevalent.

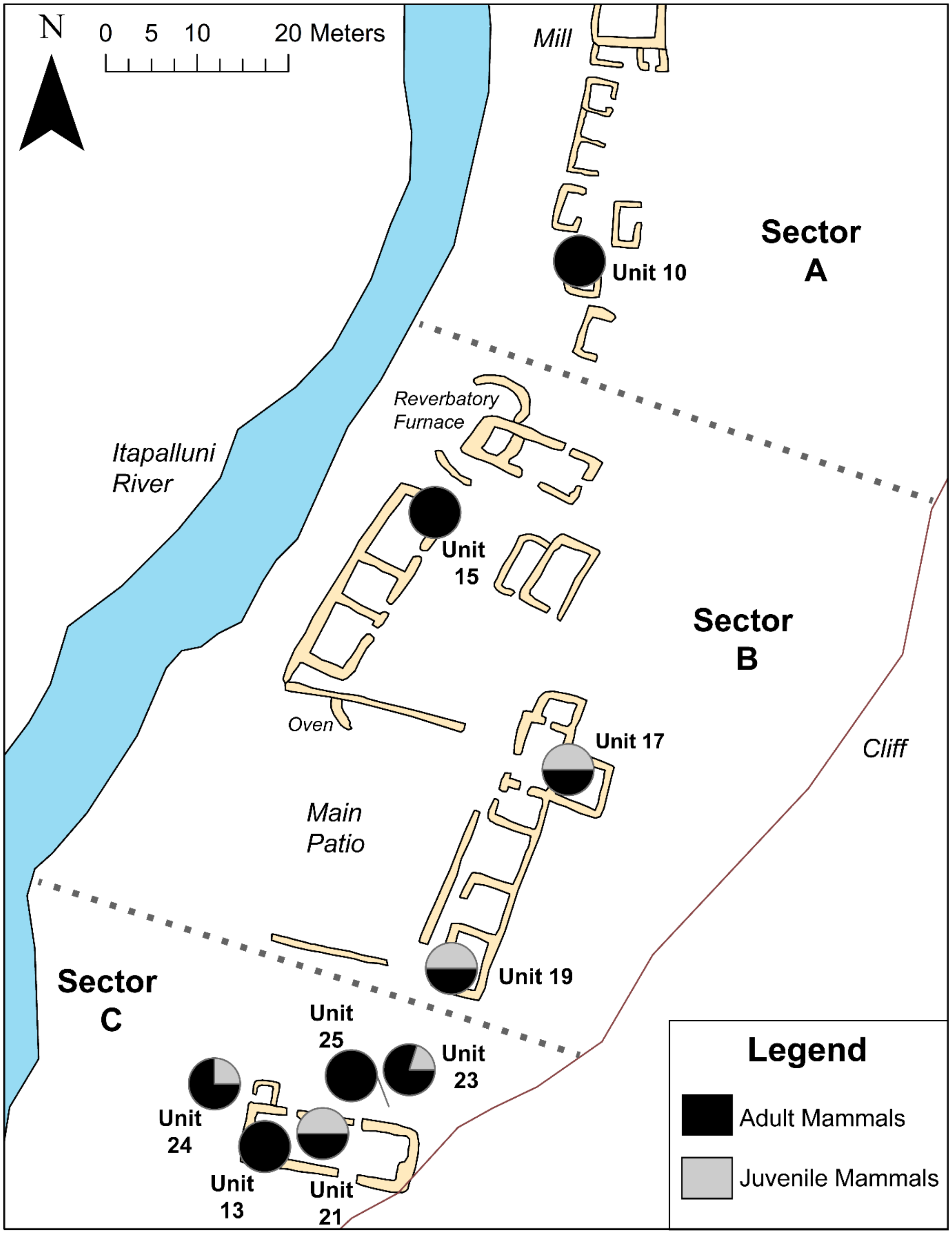

Figure 9.13: Percentage of animal bones identified to either adult or juvenile age classes using NISP.

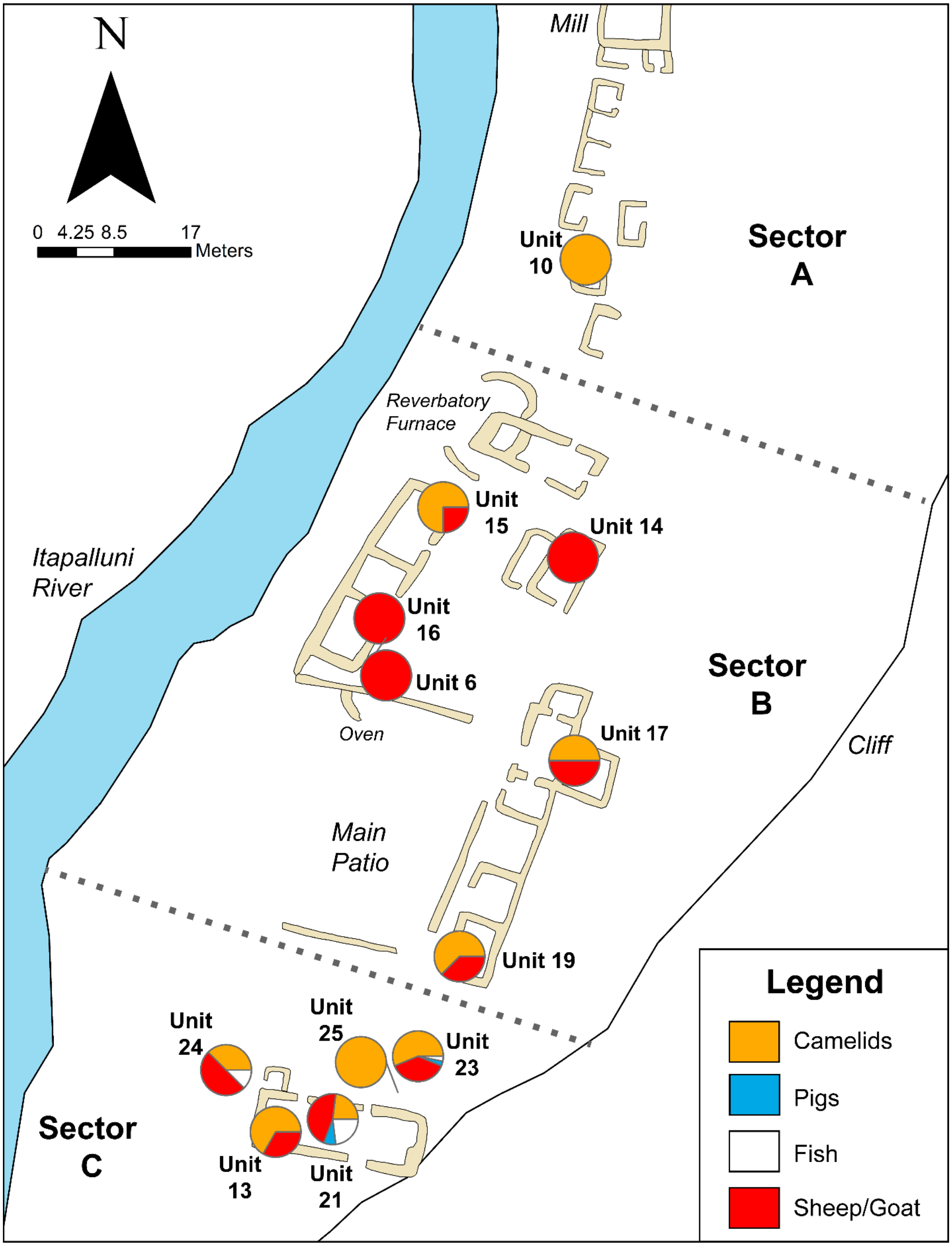

Figure 9.14: Percentage of camelid, pig, fish, and sheep/goat remains in units at Trapiche (NISP).

9.3.2 **Intrasite Macro-Botanical Patterns**

The results of the multivariate analysis also revealed strong associations between high-status fruits at Trapiche (peaches and grapes) with higher-status exotic objects, Spanish olive jars, and Inka-like ceramics. Peaches and grapes also patterned strongly with cooking sherds, which indicate a suite of variables related to self-reliance at Trapiche. These results reveal restricted consumption of high-status plants, namely fruits, at Trapiche. Peaches were only present in Unit 19, Sector B, in the overseer/owner house. Grapes were only present in Sector C in contexts surrounding the chapel and the church caretaker's house (Figure 9.15).

I consider grapes and peaches to be markers of status at Trapiche because they would not have been cultivable locally due to the high-altitude and extremely marginal nature of the Puno environment. Some Old World fruits, such as peaches and watermelon, *were* adopted and consumed by indigenous peoples of the Americas following the Columbian Exchange and were not always considered a marker of Spanish or Iberian identity (Ruhl 1990:556). However, these instances come from Spanish Florida, where the environment was much different than the high Andes, and much more hospitable to fruit cultivation. Grapes are especially linked to higher-status and ecclesiastical activities as they are directly associated with wine used during Catholic mass and communion and reflect the transubstantiation of wine into the blood of Christ during the Liturgy of the Eucharist (Rubin 1991). While grape seeds do not necessarily signal wine, their presence in contexts surrounding the chapel mark that space as one of higher-status.

These results mimic foodways data from the colonial *reducción* of Carrizales, located on the north coast of Peru (Kennedy and VanValkenburgh 2016; Kennedy et al. 2019; VanValkenburgh 2012). At this 16th century resettled indigenous town, private and secluded ecclesiastical areas surrounding the colonial church were shown to have elevated levels of grapes and black pepper, presumably used as a hard-to-acquire spice. Exotic and expensive imports such as these led to the authors concluding that the areas around the church showed affinity for the maintenance of Iberian, high status foodways (Earle 2012; Kennedy et al. 2019).

While the macro-botanical analyses reported here is only a subsample of the assemblage, as that analysis is currently ongoing, there are a few further spatial patterns that are present in the data. Quinoa is located throughout the site, in Sectors A, B, and C and may have been a staple food source for all individuals living at Trapiche. Gourds and chile peppers are also distributed throughout the site, in both laborer households and surrounding the presumed ecclesiastical and higher-status structures. Gourds may have been used as vessels and storage, while chile peppers were a local, Andean spice/condiment used to flavor foods. It is interesting to note that the only spice/condiment found at Trapiche was the chile pepper, and this was found in both high and low status households. This signals that some aspects of indigenous cuisine, such as taste, palatability, and local flavors, were maintained and accessible to a broad range of individuals at Trapiche.

Further analysis is needed to fully understand the foodways patterns related to macro-botanical remains and will be published sometime in the future at the culmination of analysis. Micro-botanical analysis of starch and phytoliths will also be important for future foodways analysis, as the presence of tubers is all but unknown at Trapiche. It is very likely that tubers made up a significant portion of the local diet during this period, although starch and phytolith are needed to confirm this assumption. The oca tuber identified in Figure 9.15 was only identified to family level by Dr. Lizette Muñoz during early subsampling (see Chapter 8), but I chose to depict it as oca to suggest the overseer/owner at Trapiche may have consumed local tubers.

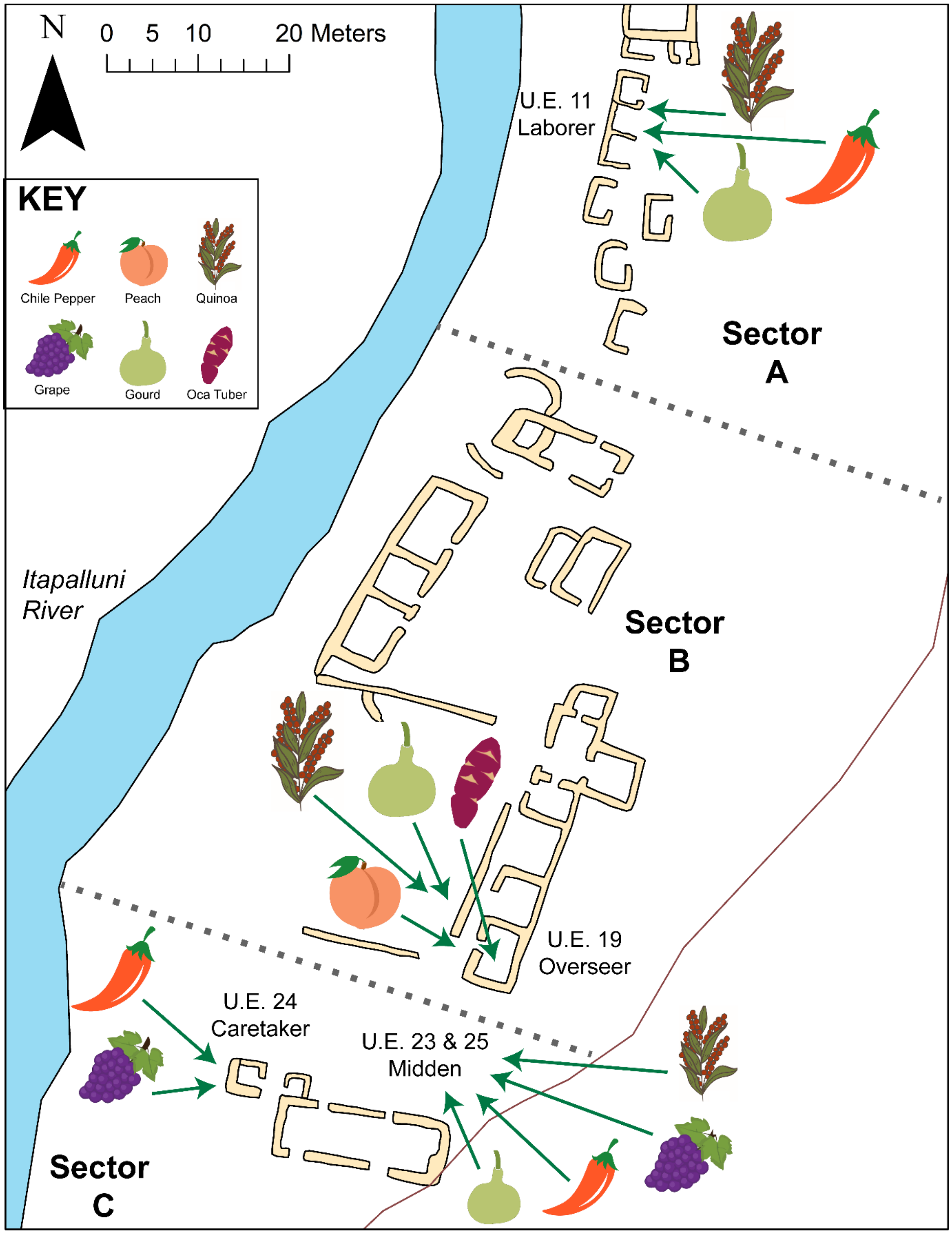

Figure 9.15: Location of botanical remains identified to date at Trapiche.

9.3.3 **Intrasite Ceramic Patterns**

The results of the multivariate analysis also revealed strong associations between ceramic categories at Trapiche. Inka-like sherds patterned strongly with Spanish olive jars, and the highest proportion of both these types came from Unit 24, the possible household of the church caretaker. Inka-like ceramics were only identified in four other units at Trapiche (Figure 9.16), in Units 10, 13, 15, and 21. Two of these, Units 13 and 21, are located inside the church/multi-purpose structure, indicating Sector C's importance. Local and colonial style ceramics were more evenly distributed across Trapiche, although Sector A had a high proportion of local ceramics in relation to Sectors B and C (Figure 9.17). Sector B's Units 8 and 14 had high proportions of colonial ceramics, correlated to silver refining.

Serving, cooking, and storage wares also patterned across Trapiche (Figure 9.18). The majority of serving wares came from Sector A, while storage wares abound in Sectors B and C (Figure 9.19). Cooking wares are found throughout Trapiche, although highest counts come from Units 15 and 19. Units 15 and 19 may have been locations of cooking at Trapiche, whereas Sector A was a location for laborers, and Sector C functioned as a multipurpose area of power, control, and ecclesiastical activities. We did uncover large amounts of cooking ceramics and a hearth in Unit 11, Sector A, and this was likely a third location for cooking at the site.

Most domestic ceramics at Trapiche lack evidence of mass-production. This indicates that either 1) laborers were providing their own household wares or 2) the owner of the refinery was purchasing locally-made ceramics from nearby potters in Puno or Chucuito. There were only 144 fragments of higher-status, mass-produced pottery at Trapiche, less than 5% of the total assemblage [fine-ware (n=42), majolica (n=58), and *botija* (n=44); total ceramic count (n=3030)]. The vast majority of forms (plates, jars, bowls, etc.) mimic local production styles.

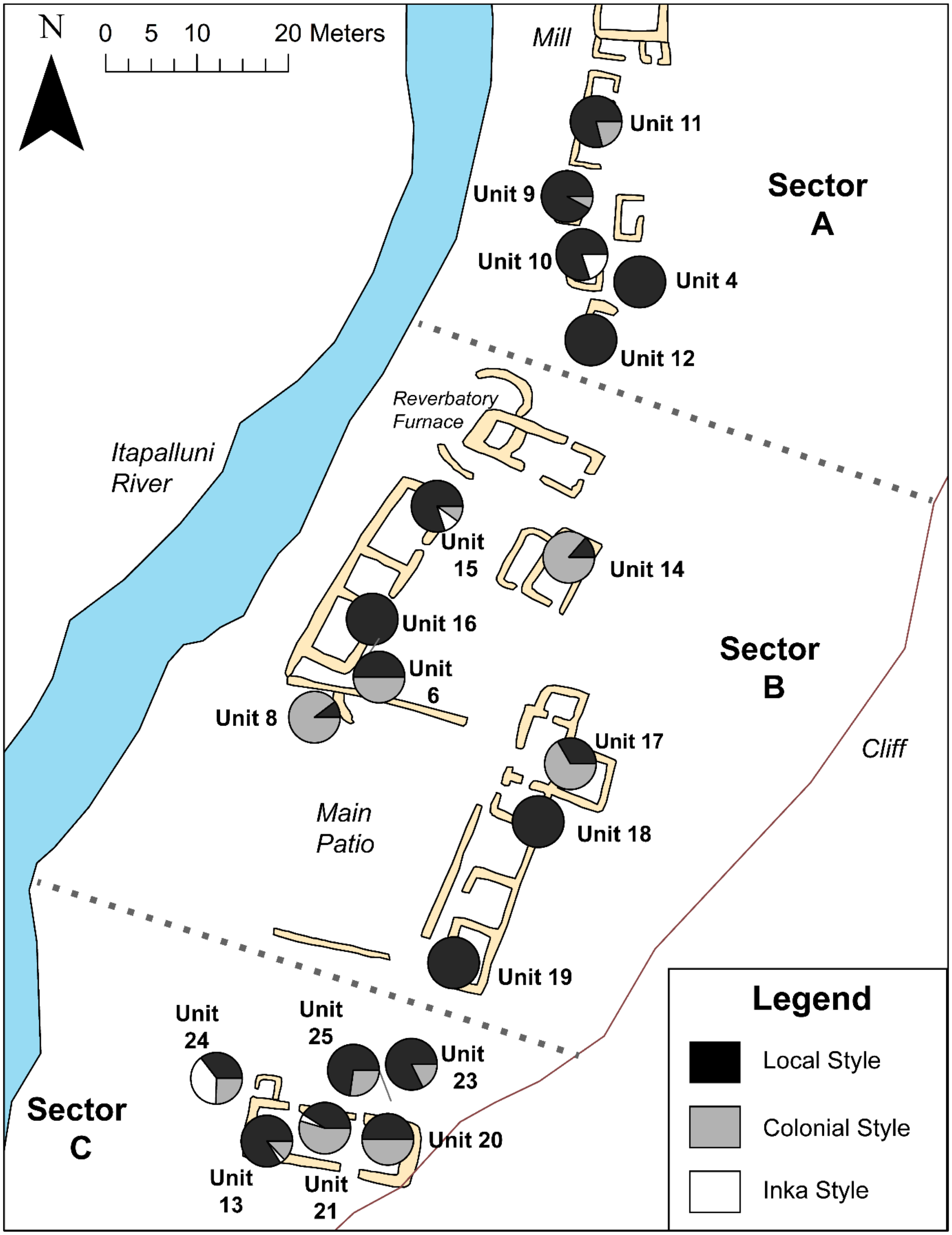

Figure 9.16: Percentage of ceramic styles in excavation units at Trapiche.

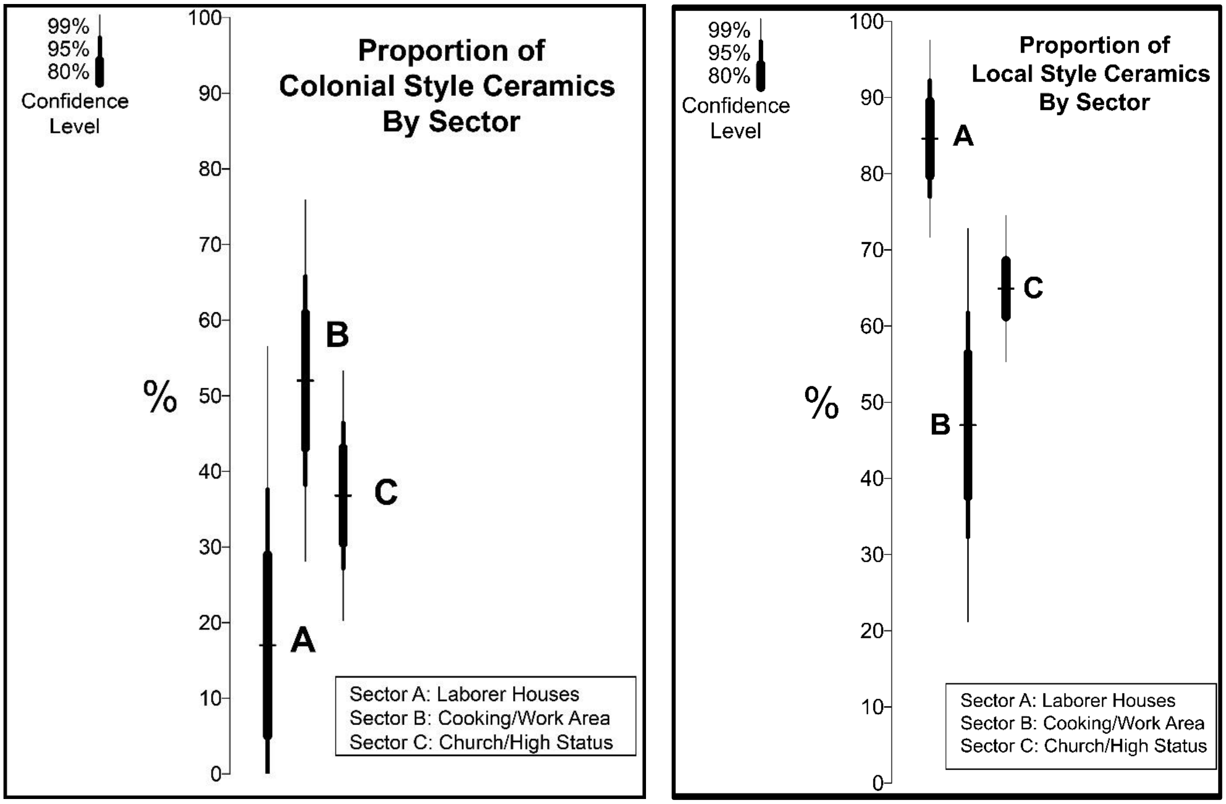

Figure 9.17: Bullet graphs depicting standard error and confidence levels for ceramic proportions at Trapiche. (Left) Comparison of proportions of colonial-style ceramics, and (Right) Comparison of proportions of local-style ceramics.

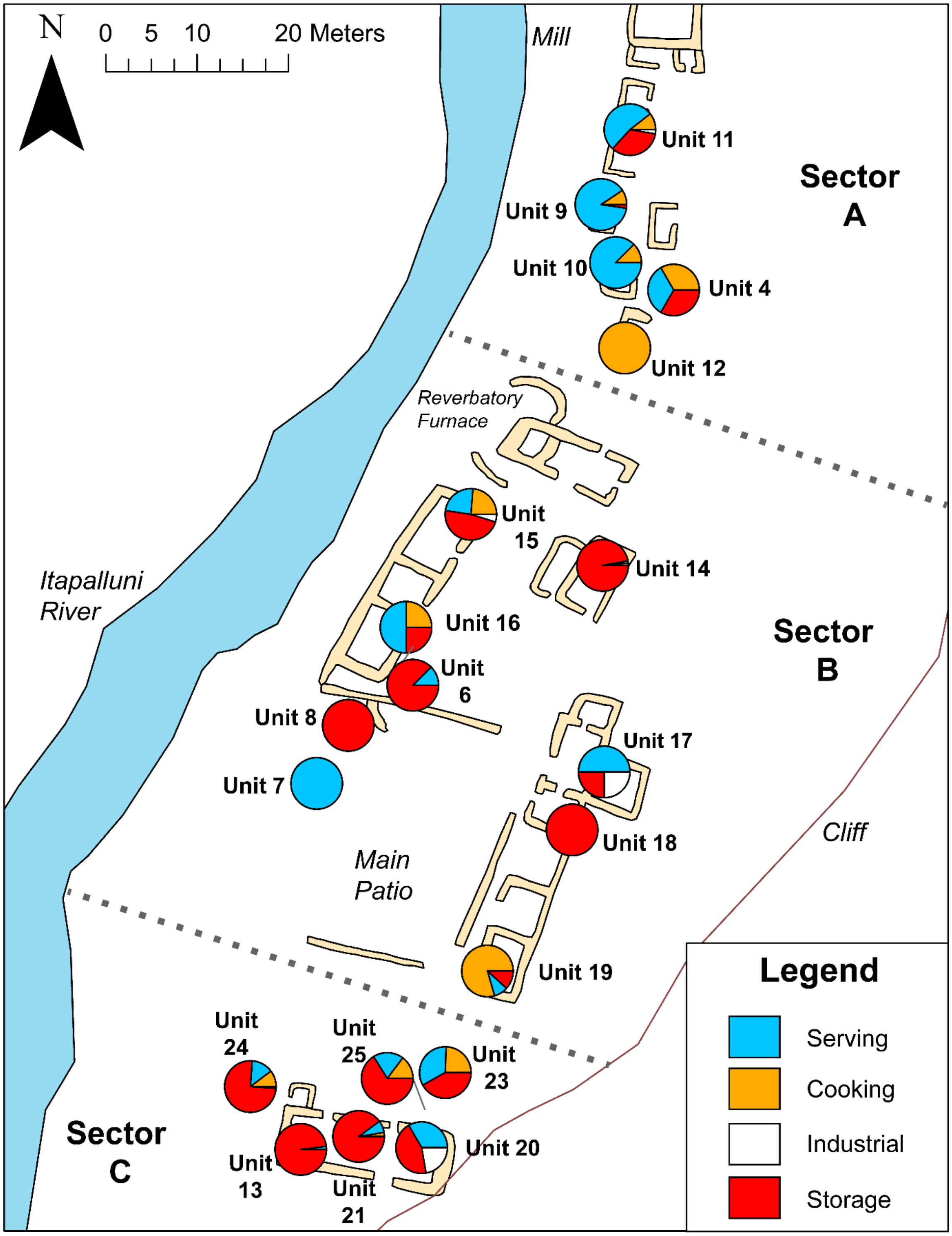

Figure 9.18: Percentage of serving, cooking, industrial, and storage ceramics by unit.

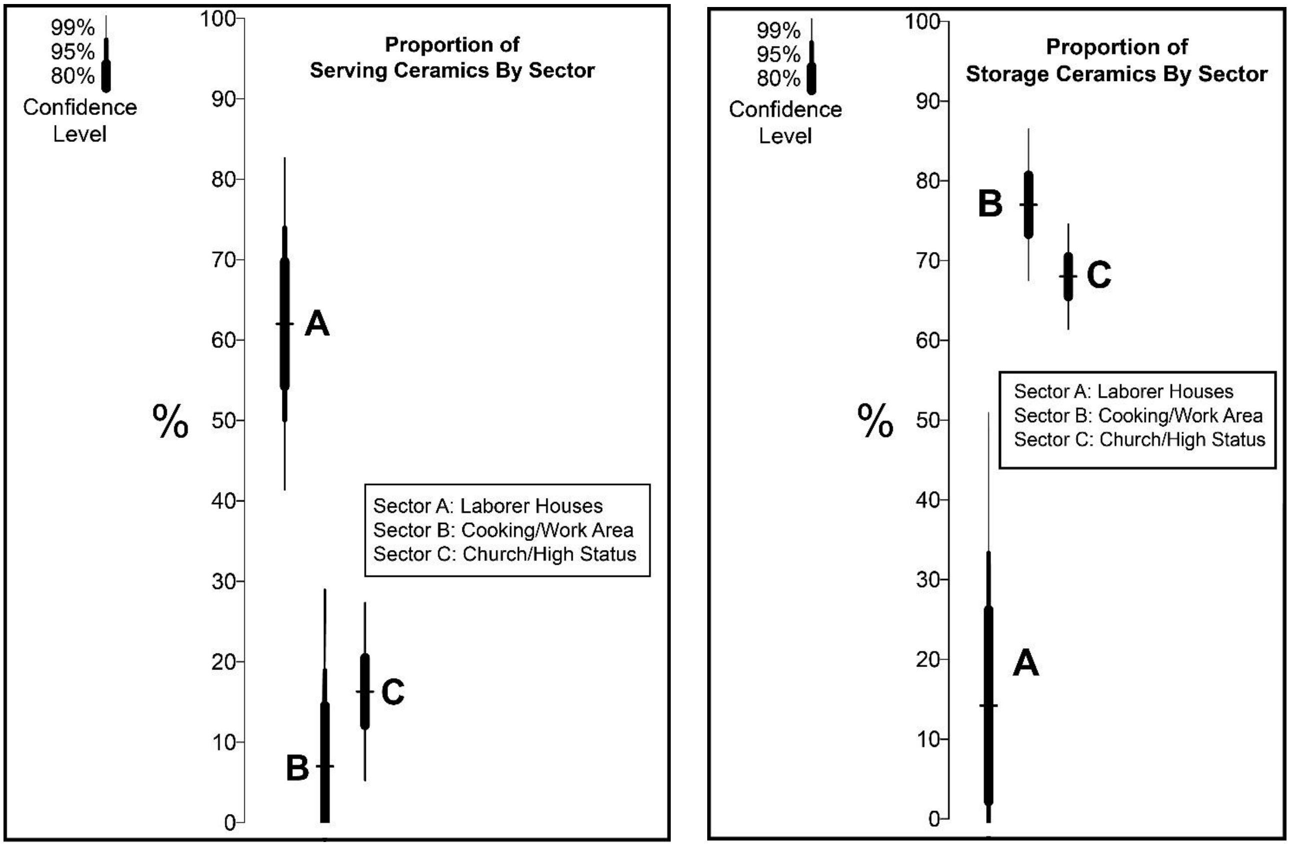

Figure 9.19: Bullet graphs depicting standard error and confidence levels for ceramic proportions at Trapiche. (Left) Proportions of serving ceramics, and (Right) Proportions of storage ceramics.

9.4 Spatial Patterns of Labor

The results of the multivariate analysis also revealed intrasite labor activities related to mercury production and craft production.

9.4.1 Silver Refining Technology

Mercury pots clustered in Units 8 and 14, highlighting these two areas as zones for specialized silver refining activities. These activities were likely associated with the later stages of the patio process, when heat was added to the process, either to volatize mercury in order to recapture it for reuse, or for earlier mercury amalgamation.

These results can be compared to the pXRF geochemical survey discussed in more detail in Chapter 6. The pXRF survey confirmed the use of the patio process with mercury at Trapiche, depicting intrasite zones of intense metallurgical activity, corresponding to locations of grinding, roasting, and heating ore. However, the pXRF analysis failed to record high levels of metals within surface soils of Unit 14. Combining the pXRF analysis with multivariate analysis aided in the identification of another location of silver refining activity at Trapiche (Figure 9.20).

Excavations also revealed more information about indigenous mining technology, such as the use of llama dung for heating and firing. In Units 8 and 14, we uncovered large amounts of burned llama dung (*taquia*) and argue that this indicates the use of llama dung to heat mercury. This suggests a continuation of indigenous fuel methods for industrial uses within Trapiche. This also corroborates historical data about the use of llama dung in the Puno Bay, discussed in Chapters 3 and 4. Specifically, a *visita* report from 1857 from the Lamparaquen *trapiche* lists llama dung (*taquia*) and wood (likely *yareta*) for their fuel supplies (Rivero y Ustáriz 1857).

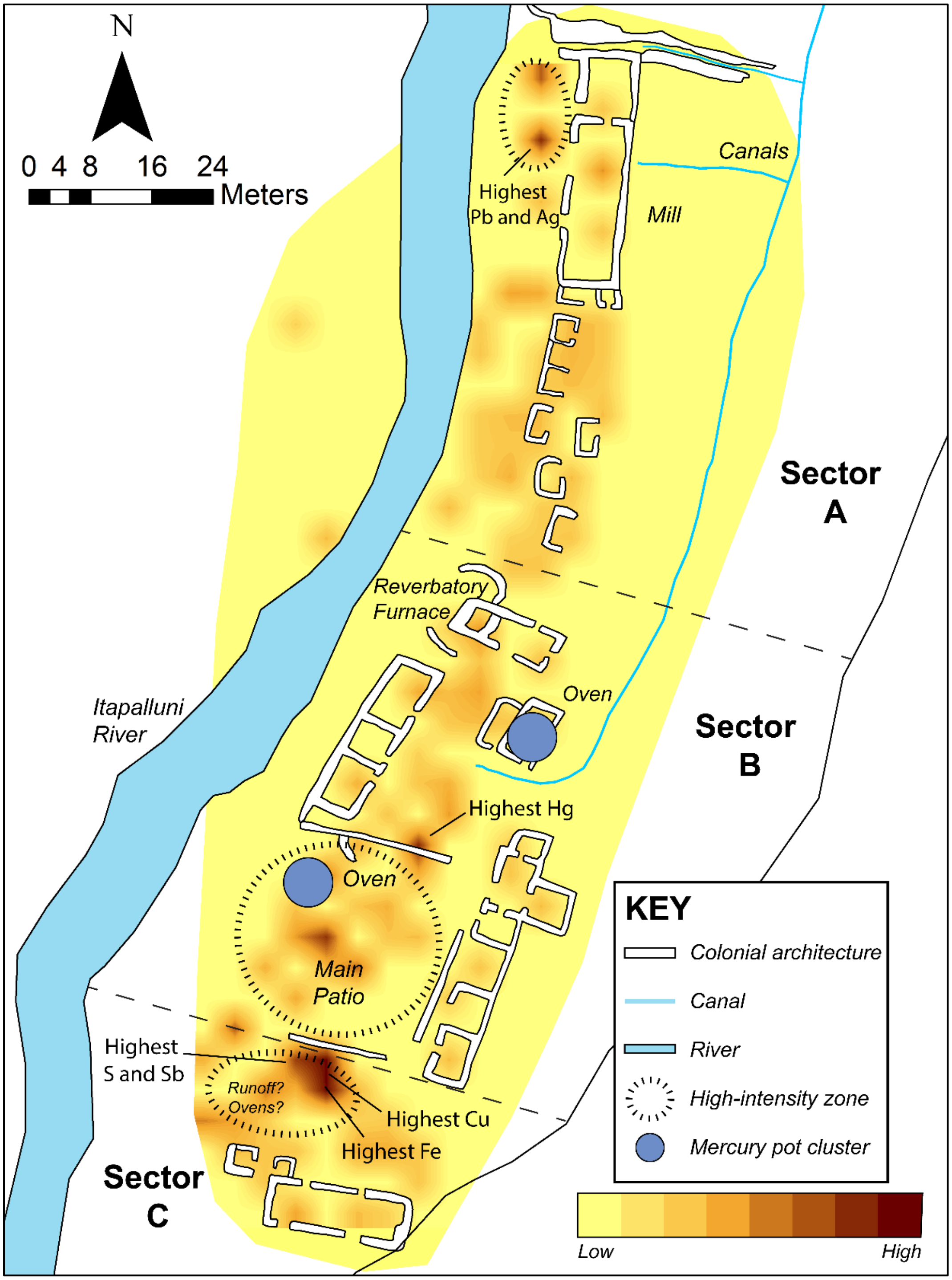

Figure 9.20: Silver refining activity areas at Trapiche.

9.4.2 Tool Use and Craft Production

Multivariate analysis also revealed spatial patterning in tool use and craft production at Trapiche. The PCA analysis revealed that component 5 was characterized by strong, positive value for the presence of specialty tools (musket ball, spindle whorls) and represented 7.9% of the total variance. This indicates that the presence of specialty tools did not pattern well with other variables at Trapiche. Specialized craft activities, such as textile production, were likely concentrated in specific areas of Trapiche. Textile production was likely a household, domestic activity at Trapiche, indicative of female presence in domestic contexts. Possibly female activities at Trapiche (weaving, cooking) were highly surveilled, although it is unlikely that the spinning of wool and textile production was a specifically controlled craft for the site.

HCA also revealed patterns in tool use at Trapiche. The final cluster in the average-linkage analysis included bones/sherds, lithics/sherds, plaster, and niche count. This cluster may indicate the clustering of variables related to status (plaster and niches), along with higher proportions of bones and lithics relative to ceramics. This cluster may indicate higher-status control over specialized craft activities done with bones or lithics, or control and surveillance of the storage of important status food items and lithic tools.

I did not identify any metal tools at Trapiche, although I recorded 35 lithic artifacts. Most of these came from the laborer houses, and included scrapers, cores, and flakes made of chert and obsidian. This indicates a continuation of prehispanic tool use, although it is also likely that laborers were not given or could not afford metal tools.

9.4.3 **Visibility and Control**

While not measured directly during the multivariate analysis, patterns in Trapiche's site usage of silver refining technology and goods reveal some level of restriction and control, highlighting results from Chapter 5's space syntax analysis. The majority of the silver refining processes took place in the open-air patio, near the mercury oven. This patio was bordered on the north and south by stone walls, and on the east and west by a steep cliff and the river. To the east of the patio, along the steep cliff, sits the administrative, higher-status structures of Trapiche. One of these structures has been identified as the household of a higher-status person, possibly the site's overseer or owner. Direct visibility and surveillance of the main patio from these eastern buildings was possible, and highlights some of the ways indirect control took place at Trapiche, even though we do not have evidence of large architectural walls or restrictions.

9.5 Provisioning

Understanding provisioning at Trapiche is integral to understanding how laborers were connected to markets and home communities. To review, while early generations of indigenous laborers brought their families with them to mining settlements and were further provisioned with food and supplies from their home communities (Cobb 1949; Stern 1993), these traditional economic and social systems may have broken down by the time Trapiche was occupied. Still further, because of the removed location of silver refineries, Trapiche may represent an extreme example of marginalized labor where male laborers lived in isolation, cut off from their families and support networks. If this were the case, we would expect to see smaller domestic structures without evidence of household-level domestics practices, such as fireplaces, grinding stones, spindle whorls, and middens. This is not the case at Trapiche, as it appears that the site was not as isolated as its location would indicate.

9.5.1 **Cooking and Serving**

Multivariate analysis, such as MDS, revealed a strong correlation of cooking ceramics in Units 15 and 19. PCA revealed that component 6 was characterized primarily by a strong, positive value for the number of cooking ceramics and represents 8.9% of the total variance. This reveals that cooking ceramics alone represent almost 10% of the variance of the Trapiche variables. Additionally, cooking ceramics did not "load" with other variables and are found in relative isolation to other variables of this analysis. The isolation of cooking ceramics at the site indicates cooking areas at Trapiche were concentrated in specific, controlled zones. These findings confirm the hypothesis that cooking of goods was centralized at Trapiche.

Cooking hearth presence also corroborates the view that food provisioning centralized, as we uncovered very few private cooking hearths at Trapiche. One private cooking hearth was uncovered in Unit 24, Sector C, the caretaker household, while another hearth was uncovered in Unit 11, in Sector A, a laborer household. The hearth in Sector A is presumed to have been a larger, potentially communal hearth for laborers at Trapiche. The hearth in Sector C was likely a private cooking hearth for the caretaker. The lack of more private hearths at Trapiche indicates a more centralized food provisioning system.

Multivariate analysis also revealed a strong relationship between serving sherds and the low-quality houses at Trapiche, revealing that laborers who lived in these houses were more likely to have large amounts of serving ceramics. This again reveals a centralized food provisioning system with Trapiche. Because laborers likely did not cook or prepare their own meals, we only find evidence of serving and consumption.

9.5.2 **Trash Disposal**

Trash middens were also centralized at Trapiche, and only one potentially communal midden was identified for the entire site (Units 23 and 25). Household refuse was uncovered in Units 11 and 19, although I do not consider them to be comparable to the large trash midden we found in Units 23 and 25. The majority of animal remains recovered from Trapiche came from the large midden. This indicates that trash disposal was centralized, although it is unclear if this is the result of surveillance or solely the result of marginal, communal living without other areas to deposit one's trash.

9.5.3 **Market Provisioning**

Analysis of faunal, botanical, and ceramic data all indicate centralized provisioning of goods at Trapiche. If the majority of food supplies were being imported to Trapiche, either as dried foods (*charqui, chuño,* dried fruit), standardized meat cuts purchased from a butcher shop, sacks of quinoa and tubers, or beverages in olive jars such as *chicha*, wine, and water, the likely source of these commodities are the towns of Puno and Chucuito. Least cost paths were calculated in ArcMap from Trapiche to these colonial towns, using standards set for human walking time using the Tobler function (Figure 9.21). I used the underlying DEM to calculate elevation, and as the paths from Trapiche did not need to cross rivers, I did not consider challenges of flooded areas or heavy rain (although this would increase travel time).

If laborers walked to other areas outside of Trapiche on weekends or on free days, they would have needed a half day to travel to Puno (3 hours one way) or whole day to travel to Chucuito (5 hours one way). These are the only two colonial towns that would have supported a market and butcher shop, and they both sit on the main colonial road through the area (Figure 9.22). The other silver refineries near Trapiche are located within a half day's walk to Trapiche (1-3 hours one way), with one small unnamed refinery located within a 30-minute walk.

The small hamlet of Malcomayo is within an hour's walk from Trapiche, one-way. Historical documents are inconclusive whether Malcomayo was a small settlement occupied prior to modern times. If it was occupied in the 17^{th} and 18^{th} century, laborers may have walked there after work, to reside with their families. It is still unclear whether laborers 1) were permitted to leave Trapiche during the week, and 2) were required to work nonstop, including at night.

The LCP results indicate that laborers were not likely walking to the colonial towns or markets themselves, and a supplier would have likely brought food and supplies from Puno or Chucuito to sell to the refinery owner/overseer. This may have included locally produced ceramics. Goods from Puno and Chucuito may have been supplied to Malcomayo as well if it were occupied in this period. It is most probable that a tradesmen or supplier with a team of mules would been needed to carry enough provisions and supplies to the Trapiche silver refinery for at least 10-20 individuals working at least 1-2 weeks without a break.

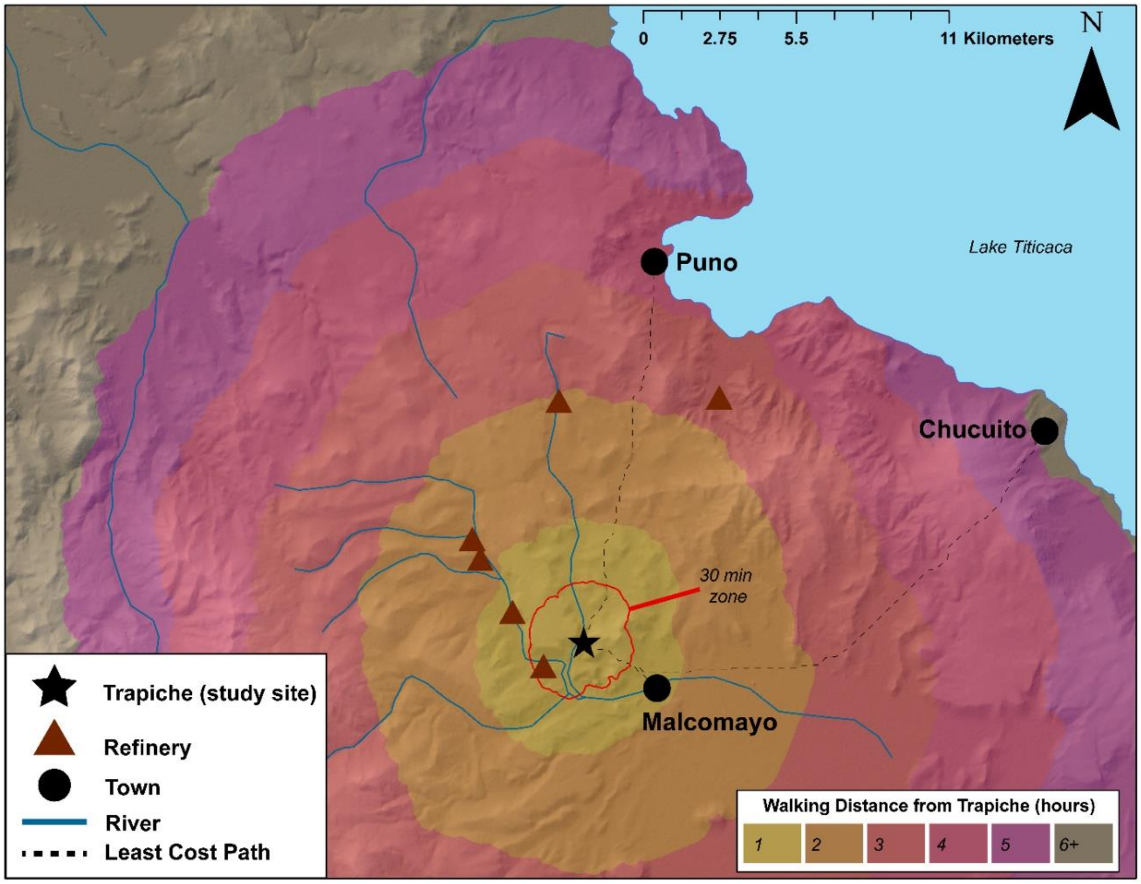

Figure 9.21: Least cost path analysis, showing easiest walking paths from Trapiche to nearby towns. Walking paths are calculated one-direction, so they would need to be multiplied to estimate total travel time.

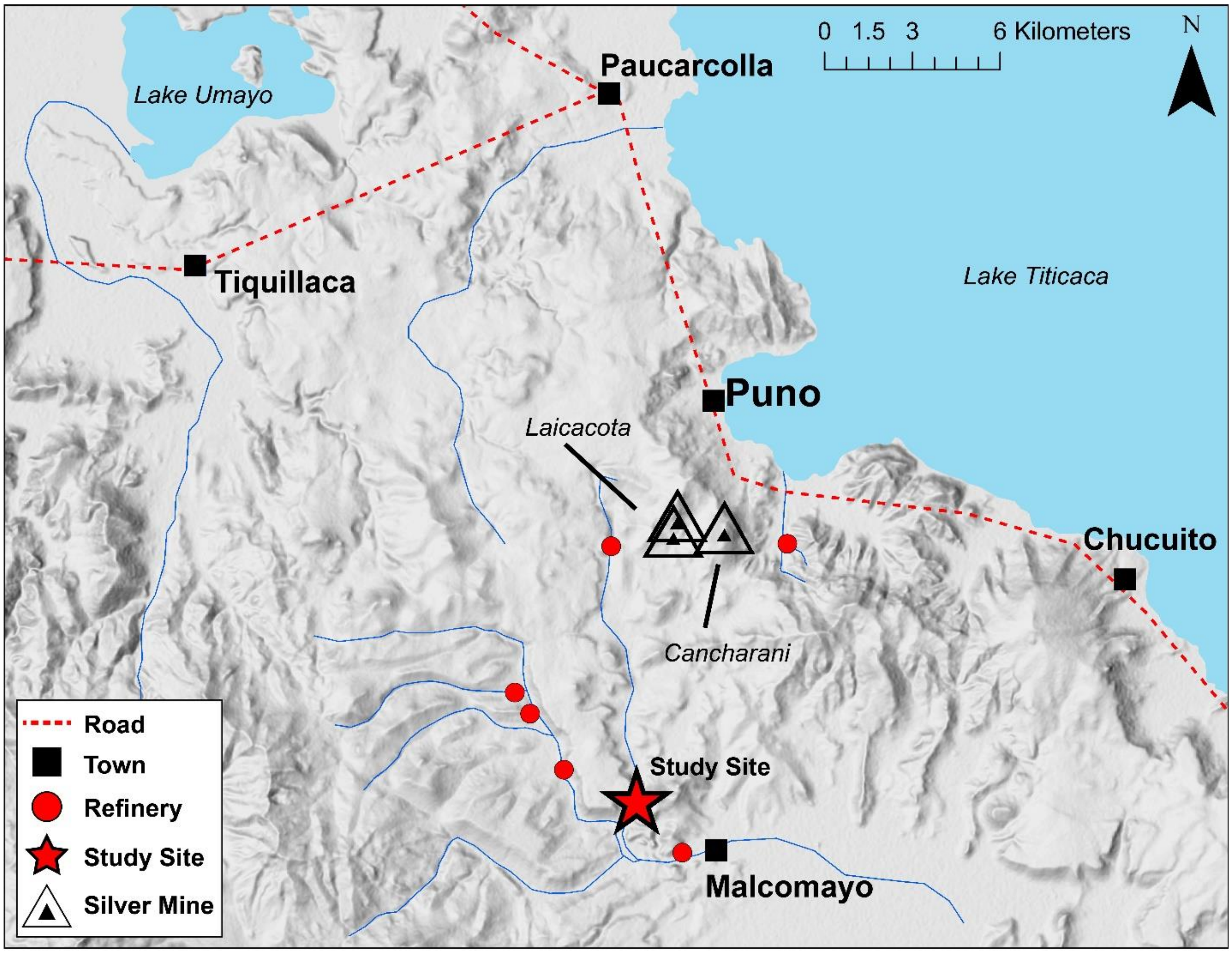

Figure 9.22: Map of Puno Bay, showing the route of the colonial road system through the area, passing through Puno and Chucuito.

9.5.4 Market Animals vs. Locally Raised Animals

The majority of food products at Trapiche appear to have been imported and provisioned from a market source, opposed to local subsistence. This is especially true regarding beverages and plant-based foods, as the Puno climate is very marginal in the altiplano zone. Animal skeletal frequencies corroborate market purchasing and long-distance provisioning. More valued portions of the carcass are transported longer distances and/or sold at market locations. One major skeletal trend that stands out in the Trapiche data is the large amount of forequarter elements (mostly humeri) from camelids (Chapter 8). These results indicate a preference for one specific, higher value cut of meat, likely from a market. This is corroborated by evidence of sawing during butchery on these specific bones, representing standardized butchery practices in a market setting.

Some faunal remains appear to indicate that local animal husbandry of sheep and goats was possible during site occupation. High proportions of foot elements from caprids were present at Trapiche (see Chapter 8 for more detailed review). This may indicate primary, on-site primary butchery of caprids. However, it is also possible laborers were being provisioned with especially low-quality cuts of mutton, such as feet, especially because cut marks on these bones do not indicate primary butchery. While some camelids also died on site (in addition to the caprids), possibly while being used to transport ore and supplies, most meat was purchased in a market. Those animals that died locally may indicate that some laborers brought animals with them to pasture near Trapiche while they worked, possibly tended to by women and children.

9.6 Discussion

Space syntax at Trapiche revealed the site to be less controlled and more integrated than other refineries in the area, such as Chorrillos (see Chapter 5). Laborer housing at Trapiche was low-quality, small, and somewhat temporary. Structures would have fit 2-4 workers in tight quarters and appear to have also been intermittently used as storage structures.

In contrast to laborer houses was a larger structure with plaster walls and floors, which was possibly the residence of an overseer or owner. The structure is located high on a hill, overlooking the work patio, and contained objects of higher status, such as copper finger rings, a silver coin, and diverse and high-status foodstuffs, such as peaches and guinea pig remains. Guinea pig meat is considered a delicacy and special festival food in the Andes (Descola 1968:130-131), while peaches are a Eurasian product that could not have been grown locally.

Diet and subsistence strategies are also important indicators of status and inequality. We recorded a mix of native and Eurasian animal taxa at Trapiche including camelids, guinea pigs, horse/burro, cow, pig, sheep/goats, chicken, wild birds, and fish (Chapter 8). The spatial division of faunal remains suggests some difference in consumption patterns at the site. In Sector A, the location of small, temporary indigenous worker households, we only find the remains of camelids and horse. In Sectors B and C, we have a much more diverse collection of taxa including wild and domestic animals. In Unit 19, the possible overseer/owners' house, we find a mix of native and Eurasian taxa, including camelid, guinea pig, sheep/goat, and wild bird. In Units 21 and 24 (located in the possible church), we find the richest collection of species with 10 taxa identified. These include domestic pig and fish from the Perciformes family (ray-finned fishes), which was likely a marine-water fish, indicating salted fish brought from the ocean.

Excavations revealed unequal living conditions at the site. The laborer houses were small, poorly built structures located near the loud and dusty mill. These structures included remains of serving plates, lithic tools, burned food remains, and personal items such as a spindle whorl, beads, and a llama figurine. The spindle whorl, used to spin wool into yarn, indicates female presence. The llama figurine may have been a religious idol related to indigenous beliefs.

Evidence of the social realities of Trapiche laborers include the presence of *tupu* shawl pins, beads, and spindle whorls for weaving, all of which indicate the presence of women at the site. These artifacts were found throughout the site, in Sectors A, B, and C. Often, women's work in colonial mining contexts has been overlooked. For example, Bigelow (2012, 2016) has identified examples of female mining knowledge present in colonial legal cases, documenting over one hundred cases of female miners and refiners in the Andes throughout the 16^{th} – 19^{th} centuries. The presence of these objects indicate families may have been present at Trapiche, even though it was a seasonal and isolated refinery. At the very least, we can say we do have evidence for female presence at the site.

One of the most interesting finds during our excavation was that of an apparent stone llama figurine, although we only found its hind end. This was recovered on top of a stone floor in Unit 11, in Sector A. This is the household we consider having housed indigenous laborers, and it was directly south from the refining mill itself. The presence of this figurine, and the lack of any type of Catholic religious icon, indicates some tie to indigenous identity.

Finally, we were able to assess well-being of Trapiche residents by using the levels of heavy metals in the site's soils as a proxy for risk exposure (see Chapter 6). The highest levels of toxic lead, mercury, arsenic, and antimony clustered around the grinding mill in Sector A, as well as the work patio in Sector B. Indigenous laborers would have frequented these areas for multiple hours each day, increasing their level of exposure. The dust from the mill would also have been thickest in the areas downwind and closest to the mill, which included the laborer houses of Sector A. Administrative houses, as well as the house of higher-status overseers and caretakers, were located in Sector's B and C, outside the reach of much of the toxic dust. While we did not find any evidence of human remains at Trapiche, we suggest that exposure to heavy metal poisoning was variable across the site. Our analysis of architecture and well as soils indicate that higher-status people were able to avoid direct exposure to toxic levels of lead and mercury, while common laborers were not so lucky.

9.7 Summary

Living conditions were unequal for laborers and higher-status individuals at Trapiche. My archaeological and survey data indicate very centralized food provisioning at Trapiche, and most foodstuffs were purchased at a market and were not raised locally. Results from the site reveal a series of contradictions in refinery life. Spatially, Trapiche was less restrictive and controlled than other refineries in the region. Workers used the same lithic tools and culinary equipment that they did before the Spanish conquest and consumed a traditional Andean diet of camelid meat. The meat was generally from good quality cuts purchased from a market.

However, conditions were unequal at Trapiche. Workers were constantly exposed to toxic levels of lead and mercury. They also slept in small, temporary houses near a loud and dusty mill. These contradictions reveal the fluidity of daily life within refineries. While unequal and often dangerous, refineries also provided economic opportunities for marginalized peoples, where other such opportunities were limited during this period. Laborers likely made informed, economic choices to enter the silver refining industry for a few months every year, increasing their access to wages and an array of market goods. They may have even brought their families and animals with them, offsetting many of the economic and social risks of this industry.

10.0 Conclusions

10.1 Introduction

To end this dissertation, I first return to the parable that opened Chapter 1, reflecting the traditional way colonial mining has been represented, especially in the 18th and 19th centuries. In Chapter 1, I introduced the myth of the discovery of the Laicacota silver mine near Puno, Peru in 1657. This myth placed Joseph de Salcedo front and center as the story's hero, to the detriment of native actors who were either absent or passive and silenced in the historical narratives.

Unsurprisingly, parts of the Laicacota myth are still prominent in Puno today. The Salcedo brothers are depicted as heroes who initiated a "golden age" of silver production in Puno. They are also viewed as valiant soldiers, who fought for colonial Puno's mining and refining rights when the Spanish Crown attempted to take them away from the Spanish gentry. Oral histories in the region continue to describe the silver refineries around Puno as military forts, instead of industrial mills and/or labor camps, and stories abound about how Joseph de Salcedo defended Puno citizens from attacks by the Royal military at these sites (Basadre 1945).

The myth has become so widespread, it has obscured the real importance of colonial Puno as a location where Andean knowledge and agency contributed to a productive system of silver mines and refineries that lasted for over two centuries. It is my hope that this dissertation has played a small part to repeople the refineries, and to add indigenous and marginalized actors back into the story of colonial Puno, where they belong.

In the following pages of this chapter, I will summarize my dissertation findings, highlighting the social narrative of silver refining laborers in colonial Puno. Following a summary of my dissertation's findings, I will pan out and situate my study within the larger body of research about colonial mining in the Andes.

10.2 Dissertation Summary

This dissertation investigated conditions of indigenous labor at colonial silver refineries in the western Lake Titicaca Basin of southern Peru (1600-1800 AD). My research found that over time, opportunities for marginalized and lower-status individuals in the silver refining industry in the Puno Bay increased. Ownership of mines and refineries became less controlled over time, while paid labor became more popular. In conjunction, diversified seasonal work was also more prevalent over time. Within the silver refineries themselves, I found variation in the amount of control and exploitation of workers. Some refineries would have been poor places to work, while others were less restricted and controlled. This was also true of individual spaces within the refineries themselves – some areas were better than others. This is particularly evident when looking at exposure to dangerous working conditions and heavy metals.

Inside the Trapiche Itapalluni refinery itself, I found that even though architecture and space was unequal, restrictive, and controlled, access to diverse economic resources, local and imported, was accessible for multiple classes of workers. Overall, I argue that silver refineries provided new economic opportunities for marginalized communities in southern Peru during the 17th and 18th centuries.

Returning to my research questions which I first presented in Chapter 1, I will summarize my research findings here. More detailed descriptions of my findings have already been presented throughout the chapters of this dissertation.

1) What was the colonial silver refining industry like in the Puno Bay?
2) What was daily life like for refinery laborers in the Puno Bay?
3) How did silver refining opportunities change over time in the Puno Bay?

10.2.1 What Was The Colonial Silver Refining Industry Like In The Puno Bay?

10.2.1.1 Puno Refining Technology

Results of this dissertation revealed that the silver refining technology employed in the Puno Bay was different from many other mining centers in the Andes, due to its comparatively late start in the mid-17th century. As detailed in Chapters 2 - 4, the first large colonial period silver boom did not occur in Puno until the 1660s. This was well after the introduction of the patio process with mercury amalgamation to the Andes, which occurred in the late 16th century.

The earliest silver refineries in the Puno Bay date to roughly 1640 AD. These were all small-scale *trapiches*, located near water sources. They combined both European and Andean technology, and my research recorded a number of Andean *quimbalete* (human-powered) grinding stones at these sites. The first three recorded silver refineries in the area were listed as *trapiches*, and larger *ingenios* were not built until the 1650s and 1660s. These terms are misleading, however, as our research has shown that many refineries in the Puno Bay had a mix of *trapiche* and *ingenio* traits. More accurately, we can say that the early refineries were smaller-scale and located near Puno, while the later refineries were larger and located further down regional water sources.

We did not find any evidence for Andean *huayrachina* smelting furnaces built within the Puno Bay silver refineries, although they might have existed concurrently in areas outside of the refineries which we did not survey. However, as mentioned above, we did find Andean *quimbaletes* in some of the Puno Bay refineries. We also found evidence of llama dung (*taquia*) being used as fuel for the refineries, which was also a prehispanic metallurgical practice.

Results from portable X-Ray fluorescence spectroscopy (pXRF) (Chapter 6) revealed specific activities areas at Trapiche, including the grinding mill, the reverberatory furnace, and the main patio used for mercury amalgamation. High levels of mercury, copper, and sulfur in the main patio of Trapiche confirmed the use of mercury amalgamation with the addition of copper sulfate during the patio process. Further, the pXRF analysis located chemical signatures that confirmed the roasting of ore with salt, the addition of heat during the amalgamation stage, and the addition of add-ins, such as copper and iron, in the last stage to reduce silver chloride to elemental silver.

These results reveal a mix of prehispanic and European technologies in the Puno Bay by the mid-17th century. Although the Puno Bay was not one of the largest Andean centers for silver mining or refining, technological advances were prominent from the beginning of its initial silver boom and lasted until the 18th century.

10.2.1.2 Puno Refining Labor

Due to the smaller-scale operation of the Puno Bay silver refineries, historical documents describing the Puno Bay labor force were difficult to find. However, even with few historical records, a nuanced and complex picture of silver refinery labor emerges.

The vast majority of the records we found on silver refinery labor in the Puno Bay listed indigenous laborers as *indios voluntarios* (voluntary workers), who were paid for their labor in wages or goods. A 1753 mining report details over 60 *indios voluntarios* working at an unnamed

Puno Bay silver refinery (possibly the site of Chorrillos) (Galaor et al. 1998:146). These workers were likely a mix of men, women, and children from surrounding areas of the Puno Bay, drawn to the seasonal industry for increased economic opportunities. Other refinery laborers were forced into the labor through a variety of coercive conditions, and workers at Trapiche likely aligned with more than one historical labor category. For example, they might have worked as *mitayos* during the week, and then as *voluntarios/mingas* on the weekends. There was no clear boundary to these laborer categories (see Chapter 2).

The *mita* forced-labor/tribute system was also still at work in 17th and 18th century Puno, although it mainly pulled able-bodied indigenous men from Puno to mining centers like Huancavelica, Oruro, and Potosí. We do have evidence that in 1744, the Puno mine owner San Román y Zevallos was granted 46 *mitayo* laborers to work in his Puno Bay mines and refineries (Galaor et al. 1998:141). The *mitayos* were drafted from the nearby Lake Titicaca communities of Huancane, Vilque, Pucara, and Angara and had actually been forced to work at the mines of Aporoma before being recalled to the Puno Bay (Galaor et al 1998:134-135; 141).

While we have no direct historical evidence for the practice of *kajcheo* in the Puno Bay, it is very likely that *mitayos* were able to work as paid, hired workers (*mingas/voluntarios*) on their days off. If these *mitayos* were also working in the nearby silver mines, they likely used their free days to work in the mines as *k'ajchas*, keeping silver ore they found on those days for themselves. Then, they would be able to later work as *mingas* or *k'ajchas* within the silver refineries, refining their own ore, or at least getting paid wages to refine the ore.

There is little evidence for trans-Atlantic chattel slavery within the Puno Bay refining industry, although this does not mean it was not occurring. Often, enslaved African labor is not mentioned in archival documents, and we would need further historical research to determine the level of enslaved African labor in this industry in Puno. The one piece of evidence we have for enslaved Africans working in connection to the Puno mining industry is a documented case from 1643. An enslaved, 16-year-old Angolan named Antonio was purchased and transported from Potosí by Bernadro Enríquez Camargo, a Laicacota mine owner (ABNB ALP MIN 146/17:58v). We do not know if Antonio was forced to work in the Laicacota mines or refineries, or if he was purchased as a house slave or a personal slave for Enríquez Camargo.

Other coercive labor relationships for workers in Puno Bay refineries were also possible, although again we do not currently have evidence for this. In Pacajes, Bolivia, some *mitayos* bound for the mines at Potosí were hired out locally by their community's *kuraka* to anyone willing to pay the 150 pesos to cover the *mita* obligation (Cole 1985:39). These laborers became known regionally as *indios maharaques* and made a wage of 2 *reales* per day for local work in mines, refineries, farms, and ranches (Cole 1985:39). This practice likely occurred in Puno as well.

There are some examples of debt peonage (often referred to as the *enganche* system) happening in the mining sector in 18th and 19th century Peru, where laborers (*peones*) who owed debts and loans to local creditors were forced to work off their debts in silver mines and refineries. There were also *yanapacus*, who were paid wages by *mitayos* to take their places in mines and refineries (Tandeter 1981:109). This occurred when *mitayos* were unable to complete their own forced labor service and needed to hire someone for help.

In many of the historical documents, there are marked differences between forced labor activities and free labor activities within silver refineries. However, as I have just shown, the categories of "free" and "forced" labor were very fluid, and workers could be *both* within a single week. The documents usually describe forced refinery work having to do with the grinding mill, feeding the ore into the mill, and sifting the pulverized ore once it was ground (Tandeter 1981:101-

102). Free refinery work was more specialized, heating the ore in reverberatory furnaces and mercury ovens, as well as mixing mercury into the amalgam during the patio process.

Archaeological excavations at Trapiche were not able to determine individual classes of laborers present at the site, although we did determine specific activity zones related to grinding, heating, and mixing ore (Chapters 6-9). This reveals that specialized labor activities were present at Trapiche. However, we cannot determine who worked in each area, although given the historical documents, it is likely there was a mix of paid and unpaid laborers working and living at Trapiche.

Further spatial analysis of Trapiche's architecture and environment revealed some degree of segregation and control (Chapter 5). Laborer households were located in Sector A, near the loud and dusty grinding mill, and they might have been directly associated with forced, unpaid laborers. While the site is not surrounded by walls and is not as controlled and segregated as other refineries in the region (see the site of Chorrillos, Chapters 4 and 5), it still presented an ideal location for surveillance and control of laborers. For example, the site is bordered by the Itapalluni River on the west, and by very steep cliffs on the east. There are no trees and ground vegetation is very low, so visibility is quite clear. The administrative structures are built on the eastern slope of the cliff, with direct views of the principal patio through western-facing doorways and windows.

The results of the historical and archaeological analysis reveal a variety of labor forms at Trapiche, as well as a mix of working conditions at the site.

10.2.1.3 Markets and Provisioning

Results from artifact analyses at Trapiche indicate the site was largely provisioned by a colonial market at the towns of either Puno or Chucuito. Provisions included a diverse range of foodstuffs, such as salted fish imported from the coast, fruit, quinoa, and chile peppers. Red meat was prevalent at Trapiche and the majority of cuts came from fatty, choice-cuts from a market setting, and included camelid meat, guinea pig meat, mutton, and pork. Tubers, such as oca and potatoes, were likely eaten and used to thicken soups, given the high proportion of grinding stones at Trapiche (which would have been necessarily to produce flour from dried tubers). While our results indicate some spatial differentiation in food access at Trapiche (low diversity of animal species in laborer households; fruit only in high-status households), results from the communal midden indicate a general pattern of accessibility to good quality and diverse foods.

While Trapiche residents were provisioned with a diverse range of foodstuffs, results indicate that the act of provisioning was centralized. Meat was purchased at a distant market and brought to the site. While we do not know who purchased the meat, it was likely done by the overseer or refinery owner and distributed to laborers as rations or payment for work. Fresh meat was often rare and seen as a luxury in 17th and 18th century highland sites such as Trapiche, and it is likely that some of the meat provisions at Trapiche was dried, on-the-bone *ch'arki* (deFrance 2021; Descola 1968:130).

Our results indicate that the majority of laborers did not prepare, cook, or store their own meals or goods. This is evidenced by a higher proportion of serving wares at Trapiche, relative to cooking ceramics. There were also few cooking hearths at Trapiche, indicating that centralized cooking of meals likely occurred. Spanish olive jars (*botijas*) and Inka-style, fine ware ceramics were restricted to higher-status households. Finally, storage containers were also restricted across the site, and not present in high numbers within laborer households.

While our results indicate that the majority of provisioning was done in a centralized manner at Trapiche, faunal and ceramic data indicate space for some flexible activities by Trapiche's laborers. For example, our results indicate that a small proportion of camelid and caprid animals were killed and butchered onsite, revealing the presence of local animal husbandry in some capacity at Trapiche. Women and children associated with the laborers may have been tasked with caring for small groups of animals in pastures near Trapiche, while other family members worked in the refinery.

Artifact analysis also indicated that the majority of ceramics used at Trapiche were local in style, indicating local production. Some laborers may have produced their own ceramic wares before bringing them to Trapiche, while others may have purchased ceramics before coming to work at the refinery. This does not necessarily mean that every laborer at Trapiche produced or procured their own ceramics. More likely, the local-style ceramic plates, bowls, and storage containers used at Trapiche were purchased at local markets in Puno and Chucuito, either by the laborers or by the refinery owner and operator. Whether the ceramics were purchased by laborers or the refinery owner, we can say that the majority of ceramics at Trapiche were made and sold by western Lake Titicaca Basin potters who maintained Lake Titicaca styles and forms.

10.2.2 **What Was Daily Life Like For Refinery Laborers In The Puno Bay?**

10.2.2.1 Activity Areas

Spatial and artifact analysis reveals that use areas within the Trapiche refinery were distinct, and there appears to have been some separation of working and living conditions at the site. Results revealed distinct activity areas at Trapiche, where work tasks were separated spatially from administrative and domestic tasks.

Ore crushing, roasting, and heating took place in three specific and separate locations at Trapiche, as evidenced by the results of the pXRF analysis (Chapter 6) and excavation (Chapters 7-9). Ore crushing occurred in the refinery mill in Sector A, ore roasting took place in the reverberatory furnace in Sector B, and the heating of the ore mixture took place in the main work patio, also in Sector B. These work-related areas were different and distinct from areas of more complex, end-stage silver refining, where mercury was added, heated, and later removed for reuse. These zones of complex mercury use were located in two ovens in Sector B, within Units 8 and 14. In Unit 8, we recovered a stone and brick oven structure. Unit 14 excavations did not reveal exterior oven architecture, but the artifact assemblage, including high proportions of mercury pots and burned clay and dung, indicate Unit 14 was also inside a mercury oven.

Domestic activities, including food preparation, cooking, consumption, storage, and disposal, also took place in distinct areas within Trapiche. Food preparation and cooking appear to have been located primarily in Sectors A and B, although a small amount of cooking vessels were found in every sector, including Sector C. In Sector A, Unit 11 appears to be the only area for cooking, with high levels of cooking vessels and a cooking hearth. In Sector B, Units 15 and 19 have the highest proportion of cooking wares at the site. Private cooking was likely done in Unit 19, which was located within the possible household of the overseer or owner.

Only two hearths were uncovered at Trapiche, including the previously mentioned hearth in Unit 11, Sector A. The other hearth was found inside the structure attached to the possible chapel (Unit 24, Sector C). This appears to have functioned as a private cooking hearth for the individual who lived in this structure, who may have been a type of caretaker for the chapel. While we did not uncover cooking hearths in Sector B Units 15 and 19 (where the count and proportion of cooking ceramics were the highest), it is likely hearths were also present inside or near to these structures. However, due to our limited 2018 field excavation season, we did not fully excavate these structures, and we cannot confirm this hypothesis at the present time.

The majority of serving plates and bowls at Trapiche were found in Sector A. This differs from where the majority of cooking and storage wares were found (Sectors B and C), suggesting that serving and receiving food was the most common activity in Sector A. The storage of provisions and supplies occurred mostly in Sectors B and C. These were separated from Sector A, where laborers were served their food and where they slept for the night. Multivariate analyses revealed that storage ceramics negatively correlated with serving ceramics at Trapiche (see Chapter 9), indicating that locations where laborers were served their meals was separate from areas where goods and supplies were stored. This highlights how some space and materials were controlled at Trapiche.

The disposal of food remains, and other trash, occurred in yet another different and distinct area at Trapiche, in a communal midden located in Sector C, in Units 23 and 25. The communal midden was located near the possible overseer/owner's house at the south end of Sector B (Unit 19), as well as near the near the possible chapel/multi-purpose building, in Sector C (Structure 27). The location of the midden was likely due to the ease of access for higher-status residents of Trapiche. It may also reflect the more public nature of the patio space directly to the north of the chapel, and individuals may have gathered here more frequently than in other, more separate areas of Trapiche. Finally, the location of the midden in this area might reflect a heightened surveillance of goods going in and out of Trapiche, and in and out of the trash midden. This location would have allowed higher-status individuals the ability to monitor the flow of items. While we cannot be sure that heighten surveillance did occur near the midden, the fact that only one midden was found at Trapiche again highlights the centralized nature of provisioning at the site.

10.2.2.2 Living Spaces and Status

In addition to activity areas, this dissertation examined living spaces and housing at Trapiche. We found evidence for a variety of housing types at Trapiche, ranging from low, medium, and higher-status housing. Low-status houses were small, less well-built, and lacked plaster floors and plaster walls. They also lacked wall niches. These structures were found in Sector A, directly south of the grinding mill. I suggest laborers lived intermittently in these structures, and they were also used as storage in other periods of site occupation. We found evidence of domestic activities in these structures, such as burnt food remains, serving bowls and plates, and one hearth. We also found a llama figurine, indicative of local, indigenous religious beliefs.

Living in these structures during the high season of silver refining would have been somewhat uncomfortable. The structures were small and likely cramped for space. It appears that only some had hearths for warmth. They were also located near the loud and dusty mill, which would have been operated during the day and night if silver demand was high enough.

Medium status housing at Trapiche included larger structures, and these had a mix of niches, plaster floors, and/or plaster walls. These may have been used for more administrative tasks, such as storage of mercury and silver, storage of tools, counting and measuring of silver ingots, and other types of administrative activities. These structures may have also been used to store the mercury/silver amalgam at the end of the refining process. Further, these structures may have served as locations of surveilled activities, such as food storage (such as Unit 15). It is unlikely medium-status structures at Trapiche would have served to house multiple individuals overnight, although some individuals may have stood guard outside important structures with stores of silver and/or mercury. We did find a lead musket ball in the doorways of one of these medium-status households, indicating heightened security and protection of this building.

High status housing at Trapiche always included wall niches in combination with either plaster floors and/or plaster walls. These were also relatively large structures, compared to the small laborer dwellings in Sector A. In addition to the white lime plaster walls and floors, these structures would have been decorated with wall hangings, rugs, mats, and other decorative objects placed inside the wall niches.

The three main structures identified as “high-status” buildings at Trapiche were: 1) Unit 19, Sector B (the possible overseer/owner house, Building 24); 2) Unit 24, Sector C (the caretaker building, Building 25); and 3) Units 13, 20, and 21 (the church/multi-purpose building, Building 27). These three structures were all located near each other in the southern end of Trapiche, near the main entrance to the site from the principal road entering from the south. They would have been important areas for the control of goods and people in and out of Trapiche. They were also all located the furthest away from the loud and dusty mill, providing better living conditions for their occupants as well. The possible owner/overseer’s house, in Unit 19, was located high on a hill overlooking the site and the work patio below, and this location was also ideal for monitoring the work of laborers at the site, and for controlling the location and activity of laborers.

10.2.2.3 Gender and Identity

In addition to our results on activity areas and living conditions, we also found evidence for female presence at Trapiche. This included the remains of *tupu* shawl pins, copper finger rings, and beaded jewelry. We also found a ceramic spindle whorl indicating the spinning of wool into yarn, which is traditionally a gendered female activity in the Andes. These artifacts point to the presence of women at Trapiche, although we cannot say in what capacity. They may have been the wives or daughters of indigenous men working in the refinery, and they came to work alongside the men in silver refining tasks. Women working in silver refineries, helping to transport, sort, and sieve ore, has been well documented in primary and secondary sources (Chapters 2 and 3). We assume Trapiche was no different, and women worked alongside men in silver refining tasks.

Women may have also been at Trapiche to cook and prepare meals for the laborers, or to tend to domestic animals, like sheep and camelids, pasturing near the site. If the owner, overseer, and/or church caretaker had a wife, she may have also been present at some point during the occupation of Trapiche. We did not find any archaeological evidence for young children at Trapiche, but in this case the absence of evidence does not mean children were *not* working at the site. In many sources, young boys are recorded as working in silver refineries doing a variety of tasks and we assume Trapiche was no different (Chapters 2-3).

10.2.3 How Did Silver Refining Opportunities Change Over Time In The Puno Bay?

10.2.3.1 Ownership Changes

Our results reveal that control of silver mines and refineries changed throughout the colonial period in the Puno Bay. Over time, total control of the production chain by one or two individuals broke down and became less integrated. By the Cancharani silver mine boom of the 18th century, control of refineries and mines ended up in the hands of multiple individuals.

During the earliest phases of silver refining in the Puno Bay in the 1640s, control of the refineries was distributed among only two families, the Salcedos and the Pimentels (Chapter 4). These refineries were built before the Laicacota silver boom of the 1660s and were used to refine silver from the San Antonio de Esquilache mines. Once the silver boom was initiated in the Puno Bay at Laicacota, the same powerful individuals (the Salcedo brothers) controlled the mining and refining claims for over four decades.

The second phase of silver refining and mining in the Puno Bay was much different than the first (Chapter 3). Silver was discovered at Cancharani around 1700, although the real boom in production did not take off for another few decades. Ownership of the mining claims on

Cancharani were not controlled by the Salcedos, and were mostly divided into sections within mining collectives, with many owners. While the majority of these owners were of Spanish descent, some were powerful women from the area as well.

In conjunction with the Cancharani boom, several silver refineries were built south of Cancharani on the San Miguel/Uncalliri River (Chapter 4). This area became known as the *Ribera de Uncalliri*. These refineries were owned by many different people, and ownership changed hands more often than in the earlier Laicacota phase. Additionally, local landowners, including women, were part owners and received payments from the refineries, even if they did not own or operate the refinery on their land. Overall, our historical analysis of Puno silver refineries shows a trend toward more integrated ownership by larger groups of individuals over time.

10.2.3.2 Changes to Refineries

In addition to changes in ownership of refineries over time, our historical and architectural analysis has revealed changes and flexibility in refinery "type" over time in the Puno Bay (Chapter 4). The earliest refineries built in the Puno Bay were described as *trapiches*, notable for their small economic investment, small size, and lack of stamp-heads. The first three refineries built in the Puno Bay were called *trapiches* in the historic documents, and all were built between the years 1644-1646. These were built near water sources and combined both European technology (reverberatory furnaces, patios) and Andean hand-powered grinding stones (*quimbaletes*). They did not have large canals or reservoirs of water, nor did they have the massive stamp heads popular to the *ingenio* refineries. However, they may have had other smaller-scale grinding stones and European technology, which does not fit into the traditional "type" category used at Potosí.

Over time, *ingenios* became the more prominent refinery in the Puno Bay historical documents. During the one hundred year span of the Laicacota and Cancharani boom periods, all of the recorded refineries built in the region were called *ingenios* (1654-1753). These refineries still included a mix of European and Andean mining technologies, as many of the refineries we mapped and surveyed included *quimbaletes* (Chapter 4). Also, some *ingenios* also did not include stamp-head mills. Instead, they had smaller grist-mills. The site of Chorrillos, a very large *ingenio*, did not have a grinding mill, but instead had multiple *quimbaletes.*

The last recorded refinery built in the Puno Bay during this period was listed as a *trapiche*, instead of an *ingenio*, and it was built in 1754. Roughly one hundred years later, a 19th century refinery near the town of Lampa (80 km northwest of Puno) was also recorded as a *trapiche* in a local inspection (Chapter 4). These results point to the use of smaller-scale *trapiches* in the periods before *and* after the colonial silver rush of 17th and 18th centuries. It is likely that *trapiches,* with their lower operating costs and less controlled nature, persisted longer in the Puno Bay during bust periods, or periods of lower silver production. However, we must note that the simple *trapiche/ingenio* categories did not reflect the spectrum of variation in the Puno Bay (see Chapters 4 and 5 for a more detailed discussion).

The site of Trapiche Itapalluni may have been used more often during "bust" periods of decline, although we have yet to find historical documents that confirm the dates of construction and occupation of the site. Radiocarbon dates from our excavations (Chapter 8) reveal a long period of occupation, likely seasonal and intermittent during boom and bust cycles. The earliest dates point to the early 1600s, which align with some of the earliest *trapiches* constructed in the Puno Bay. Other radiocarbon dates point to later occupation, in the middle of the 18th century, as the Cancharani operations grew and became more profitable. Finally, a few radiocarbon dates point to a 19th century occupation, largely in the early and middle 19th century. This again may align with periods of post-Cancharani silver refining in the Puno Bay using *trapiche* infrastructure.

Our historical and architectural results, combined with radiocarbon dates from excavations, reveal a long period of lower-cost *trapiche* use throughout the Puno Bay, punctuated with a period of increased capital that made *ingenios* profitable. Again, Puno Bay *ingenios* were a mix of low and high-cost architecture and Andean/European technology, so we cannot be certain this pattern only reflects differences in capital investment. The change in name usage might reflect ethnic identity of the refinery owners, or solely a trend in terminology usage during the period.

While radiocarbon dates from historical periods are notoriously difficult to pin down (due to the folding of the calibration curve, dates with multiple intercepts and varying probabilities, atmosphere variation due to the industrial era's effect on 14C, etc.), it appears that the Trapiche refinery was occupied at different times throughout the colonial period. We have not been able to match these periods of occupation with "bust" or low periods of silver production, but it is a potential hypothesis for *trapiche* use in the Puno Bay.

10.3 Puno in a Broader Andean Context

While the majority of this dissertation has taken a regional and site level perspective to colonial silver refining, labor, power, and identity, I will now zoom out from the Puno Bay to put my results in a wider, Andean colonial context. The site of Trapiche represents one of <u>hundreds</u> of colonial refineries in operation in the Andes during the 16th, 17th, and 18th centuries. It also represents one of <u>thousands</u> of colonial refineries in operation throughout the Spanish-controlled Americas during this time. Trapiche is one site-level example of how a small, marginal, unregulated refinery operated during this period. Other silver refineries operated in less isolated settings, such as the large *rivera* of hundreds of refineries at the massive mining center of Potosí.

Throughout the colonial Andes, locations such as Potosí, Porco, Huancavelica, Oruro, San Antonio de Nuevo Mundo, San Antonio de Esquilache, Azangaro, Aporoma, Sorata, Moquegua, Tambobamba, and others, were locales of silver mining, refining, and zones of unequal labor.

I will not provide an exhaustive summary of these locations here, nor will I detail all the historical or archaeological work conducted in these areas. I will, however, select data from both large and small Andean mining sites to shed light on the patterns we see in the Puno Bay.

10.3.1 **Peripheral Refining in the Andes**

An important comparative case-study of Andean silver refining in more peripheral areas of the Spanish Empire comes from the site of San Antonio de Nuevo Mundo in Lípez, Bolivia (first introduced in Chapter 2). San Antonio de Nuevo Mundo sits at 4,700 masl and was relatively isolated from important routes and cities of the period (Gil Montero and Téreygeol 2021:71). Early silver mining exploits occurred in the 1630s and 1640s (Bakewell 1988). By the second half of the 17th century, San Antonio de Nuevo Mundo became one of the most productive silver centers of Charcas, as production at Potosí and Oruro diminished (Gil Montero and Téreygeol 2021:66). In later years, by the end of the 18th century, population had decreased, and laborers were only there 3-4 months of the year (Gil Montero and Téreygeol 2021:74). This pattern is similar to what we see happening in the Puno Bay, which also saw its first boom in production in the 1660s. Similarly, the location of San Antonio de Nuevo Mundo is quite isolated and offers an interesting comparison to patterns in the Puno Bay.

Laborers at the silver refineries of San Antonio de Nuevo Mundo came from all over the Andes, including Cusco and Potosí (Gil Montero 2014). Some of these laborers were also poor

European immigrants and enslaved Africans. Laborers lived in both mining camps and within the silver refineries themselves.

Recent historical and architectural studies at San Antonio de Nuevo Mundo silver refineries reveal that refining techniques at *trapiches* and *ingenios* did not correspond to strict dichotomies. Instead, various types of refining techniques were found in a variety of refineries and tended to be based on the environment where the refinery was located, the quality of the ore, or the investments by owners (Gil Montero and Téreygeol 2021). For example, some sites had Andean technology (*quimbaletes* and *huayrachinas*) mixed with European technology (patios, reverberatory furnaces, and stamp-mills). Others had only patios, or only furnaces. Results indicate amalgamation was the only technique present at all refineries (Gil Montero and Téreygeol 2021:76).

Overall, San Antonio de Nuevo Mundo *ingenios* did not always have stamp-heads, and may have been low-cost refineries, similar to *trapiches.* Further, *trapiches* at San Antonio de Nuevo Mundo were not ethnically linked to indigenous owners, as has been found in Potosí. The majority of San Antonio de Nuevo Mundo *trapiches* were owned by Spaniards, although nearby *trapiches* from the 18th and 19th century *were* owned by indigenous and *mestizo* individuals (Gil Montero and Téreygeol 2021). It appears that during the decline of the San Antonio de Nuevo Mundo silver mines, there were more opportunities for indigenous owners of *trapiches.* These indigenous *trapiche* owners were called *juncos* (a synonym for *k'ajcha*) and were able to be successfully self-employed during this bust period (ABNB, Minas 59 1686).

The patterns observed at San Antonio de Nuevo Mundo reflect similar patterns of refinery technology and ownership over time in the Puno Bay, although no studies at San Antonio de Nuevo Mundo have excavated laborer households to better understand laborer living conditions and experiences in this location. Overall, trends at San Antonio de Nuevo Mundo show increased opportunity for indigenous people in the silver refining industry in the 18th and 19th centuries, and during periods of decline in silver production.

10.3.2 Refining at Larger Centers in the Andes

Much of the information presented in Chapter 2 in this dissertation comes from historical documents that detail silver mining and refining at Potosí, a large urban area. Because direct comparisons with Potosí are already presented in many areas of this dissertation, I will not repeat a comparison here. Instead, I will compare the Puno Bay to another large center of silver mining in the southern Andes: Porco, Bolivia. Porco, first introduced in Chapters 1 and 2, is the large, long-term location of silver production located just southwest of Potosí. Porco is an ideal location to compare with Trapiche, as multiple decades of historical and archaeological work have been done at refineries, towns, and mines in the area.

Porco differs from the Puno Bay and from San Antonio de Nuevo Mundo in many respects. It was occupied as an important silver mining and refining center for a much longer period, from Inka control in the 15th century, throughout Spanish colonial rule, into the Republic Period, and even until today (Van Buren 2021). While it is located near its own local silver ore sources, it is also only 50 km from Potosí and sits along major market roads, making it a highly-connected silver center. Andean silver smelting technology (*huayrachinas*, *tocochimbos*, *quimbaletes*) were all present during 15th and 16th century occupation of Porco (Van Buren and Cohen 2010; Van Buren and Mills 2005). Early laborers involved in silver smelting were likely *yanakuna* and were so highly trained at Porco in refining that they left to work at Potosí during its early colonial period of silver production.

The introduction of mercury amalgamation to the Andes in the 1570s was impactful at Porco, as the heighten cost of refinery construction and import of mercury shifted the labor base. Workers at the refineries were now a mix of *mitayos* and *mingas* (Bakewell 1984; Tandeter 1993). A variety of refineries (*trapiches*, *ingenios*, and a mix of both) were operated at Porco throughout the 16th and 17th centuries, with a larger than average number of reverberatory furnaces documented in the area (Van Buren 2021:54). This perhaps signals more capital available for the construction of these large, expensive furnaces, as we do not see the same pattern in Puno or San Antonio de Nuevo Mundo.

The practice of *kajcheo* has also been documented at Porco, both in historical and archaeological contexts. Small-scale *trapiches* and individual *quimbaletes* found in conjunction with private metallurgical hearths has led Van Buren and colleagues to conclude *kajcheo* was a common, and somewhat hidden, practice in 17th and 18th century Porco (Bakewell 1984; Tandeter 1993; Van Buren 2021:55-56). Historical documents corroborate these practices, highlighting the role that women played at Porco and Potosí refineries, as women were often the ones who picked through ore waste to find valuable pieces to smelt at *trapiches* and sell on the black market (Ocaña 1969 [1608]:202-203).

To date, the only excavations at a Porco silver refinery were within a large *ingenio* at the site of Ferro Ingenio, again mentioned in Chapters 1 and 2 (Weaver 2008). While physical living conditions were difficult to ascertain at the site, archaeologists did uncover evidence of *tupu* shawl pins and spindle whorls, similar to material remains uncovered at Trapiche that point to the presence of women within these refineries.

Other material remains found in refineries and mining camps at Porco point to a greater access of market goods, likely reflective of Porco's close proximity to the Potosí markets. Spanish olive jars and majolica tin-glazed pottery were found along with possessions made of silver (silver *tupu* pins, silver tassels, silver thread). Other higher-status objects included European leather shoes, Chinese porcelain, European pottery and beads, and silver coins (Van Buren 2021). Similar to Trapiche, Inka-style provincial pottery was also found in relation to olive jars and majolica, and Van Buren and Weaver (2014) argue this pottery style was present in Porco until at least the early to mid-17th century.

Paleoethnobotanical work done by Muñoz Rojas (2019) has identified a great richness and diversity of plant taxa at Porco, including staples such as maize, quinoa, potatoes, oats, and wheat, as well as chile peppers, squash, coca, lentils, and guava (Muñoz Rojas 2019:233). Faunal analysis at Porco, conducted by Susan deFrance (2003, 2012) also identified a diverse range of species, including camelids, guinea pigs, cattle, goats and sheep, equids, domestic chickens, wild birds, fish, and crustaceans (Muñoz Rojas 2019:234). Also identified at Porco is the use of *taquia* (dried camelid dung) for fuel in hearths and ovens (Muñoz Rojas 2019:242-243).

In lower-status households at Porco, Muñoz Rojas identified larger presence of non-native lentils and local fish remains (2019:247-248). Muñoz Rojas concludes that the majority of individuals living at Porco, whether higher or lower status, laborers or overseers, had relatively equal access to a diverse diet. This, perhaps, was due to their close connection to Potosí and the market economy of the silver mining industry.

In comparison to Trapiche Itapalluni and the Puno Bay, Porco households did have a larger richness and diversity of food products, although paleoethnobotanical research is still ongoing for samples from Trapiche. Very few fish remains (n=2) were found at Trapiche, and we are left to ponder if this is a problem with site preservation, or if this represents a distinct difference in preference or provisioning. Old World plants such as oats, wheat, and lentils, as well as New World plants (corn, potatoes) have not yet been identified at Trapiche, and may have been difficult or expensive to purchase for shorter, seasonal work at the peripheral site.

Access to other goods, such as imported ceramics and beads, as well as higher-status objects made out of silver, was also more prominent in Porco than in the Puno Bay. However, other trends, such as the presence of localized, Inka-style pottery, majolica, and olive jars, were observed at Trapiche. Various laborer conditions, and various identities (women, children) seem to have taken place at both sites. Because we know less about the physical living and working conditions inside refineries in Porco, we cannot say for certain that quality of life was significantly higher in more urban, connected silver refining locations. However, access to high-quality goods, including a diverse diet, would have made living and laboring in the silver refining industry in Porco quite appealing to many different classes of workers.

10.4 The Human Experience of Silver Refining in the Puno Bay

In Chapter 1, I introduced a variety of archaeological approaches used to understand the human experience of people in the past (Arponen et al. 2016; Hegmon 2016; Robeyns 2005; Smith 2019; Stern 1987). These approaches focused on people's living conditions, working conditions, and social connections, and how these conditions fit into the wider social context of the time period in question. Many of these approaches draw on different measures of well-being and quality of life, hoping to study other aspects of past human life, in addition to the more common material correlates of "wealth" and "prestige."

In this dissertation, my goal was to do the same, and explore the lived experiences of indigenous and mixed-race individuals who lived and labored within the colonial silver refineries of the Puno Bay. I combined a variety of approaches, looking at more traditional archaeological indicators (house size, house quality, presence of high-status goods), as well as other indicators of well-being, such as economic security, health, and political freedom (i.e., freedom from coercive labor, restricted movement, etc.). Many of these measures are based on the remains of foodways, as well as the use of space at Trapiche. I also looked at how laborer activities directly related to bodily health (e.g., exposure to toxic chemicals) and control/surveillance (e.g., restriction of certain types of activities or movement).

In the end, what was the human experience like within the Trapiche silver refinery? What did it mean to "live well" in 17th and 18th century Puno? Spatially, Trapiche was less restrictive and controlled than other refineries in the region, such as the site of Chorrillos. There were no walls surrounding the site, and it is likely that workers lived both on site and in nearby hamlets and villages, without direct restriction and control of their movements. However, the physical environment where Trapiche was located (i.e., in the bottom of a steep canyon, surrounded by a river and steep cliffs, quite distant from urban towns and cities) was relatively isolated and removed from colonial urban society. Patio and workspaces within the refinery were also located in wide, open areas where constant surveillance from overseers was very likely.

While Trapiche was more isolated than the majority of refineries in the Puno Bay, it is very likely that the site was only occupied seasonally, during the rainy months where the water level of the Itapalluni River would have been high enough to power a mill night and day. Historical and archaeological data reflect shorter periods of occupation, especially in laborer houses where very little material remains were left behind after occupation. The labor force was likely small, possibly 20-30 people at the very most at any given time. Even if laborers worked at Trapiche for a set, 3-month period, it is likely family members were able to visit them, or that they visited nearby markets and towns on weekends and free days. Thus, the "capability" to maintain connections to family and communities throughout the year would have been possible, even with the semi-isolated, restricted nature of the site.

Archaeological excavations at Trapiche reveal that laborers used the same lithic tools and culinary equipment that they did before the Spanish conquest. The majority of ceramic wares were local Puno styles, with a mix of serving and cooking vessels. While cooking and provisioning appear to have been highly centralized, these activities were not necessarily restricted or controlled. Some laborers may have been in charge of cooking, or possibly their wives or daughters came to Trapiche to earn extra wages as cooks for the site. Meals at Trapiche appear to continue a traditional highland Andean diet of camelid meat, which was generally from good quality meat cuts purchased from a market. Meals were also likely traditional soups and stews, and it is probable that potatoes and *chuño* complimented quinoa in these dishes.

We did find evidence of inequality in living conditions at Trapiche, with laborer houses being smaller and made from less quality materials. In contrast, administrative structures and houses of higher-status individuals (the owner, overseer, and/or caretaker) were larger, better made, and included plaster walls, floors, and wall niches. These houses also included more Spanish olive jars (*botijas*) and tin-glazed pottery (*mayolica*), along with Inka-like fine ware pottery. They also included a much larger proportion of storage jars. Other higher-status items found here were copper *tupu* shall pins, silver coins, beads, and jewelry. Higher status houses also had greater diversity and richness of plant and animal species than laborer houses, signally more access to diverse market goods. These foodstuffs included guinea pig meat and imported fruit. While flora and fauna were more diverse, there is no indication that the quality of food products was worse in laborer households. There might have been less diversity of foods, but laborers still ate well.

Working conditions at Trapiche do point to some differences in health and likely exposure to toxic heavy metals. Laborer houses were located very close to the loud and dusty mill, as well as to the reverberatory furnace, while high-status structures were located up and away from the mill and furnace. Toxic levels of mercury and lead would have been breathed in by laborers working around the mill, furnace, and main patio – where workers were required to mix the ore/mercury slurry with their bare feet. While laborers were not working in these conditions for the entire year, even a 2-3 month exposure to these chemicals would have exposed them to toxic levels of antimony, arsenic, mercury, and lead, leading to skin and lung irritation, as well as damage to the brain, lungs, and kidneys. Long-term, chronic exposure to these conditions would have led to cancer, organ failure, and death.

While living conditions at Trapiche were unequal and often dangerous, the work would have provided economic opportunities for various types of marginalized peoples, even women, where other such opportunities were limited during this period. Laborers who had the freedom to make the choice, likely made an informed, economic decision to enter the silver refining industry in Puno for a few months every year, increasing their access to an array of market goods and economic opportunities. Working at a refinery would have provided food, and for some people, cash wages. Working at a smaller-scale *trapiche* such as Trapiche Itapalluni would have also provided more of an opportunity to practice *kajcheo*, where laborers may have illicitly gained access to ore or at least the ability to refine their own silver. Seasonal refinery work also allowed Puno-area subsistence farmers and fisher people the opportunity to join a semi-skilled labor force for a few months of the year to supplement their annual income, while the rest of their family continued subsistence farming and animal husbandry.

What does all this mean for well-being and quality of life for workers at Trapiche? While unequal, semi-restrictive, and unhealthy, quality of life was not as poor as one might expect from such an oppressive situation. More work is needed at other silver refinery sites in the Puno Bay and across the Andes, especially within laborer households in industrial contexts such as refineries. Multidisciplinary work that combines archaeological, archival, ethnohistorical, and oral histories is also needed to fully understand the nuances of the human experience during the colonial period.

10.5 Concluding Remarks

This research contributes to the study of Spanish colonialism in the Americas, and more broadly, to the study of marginalized and coerced populations within larger colonial systems. Instead of viewing colonization as a process of either domination (Spanish) or acceptance (native groups), my project builds on current approaches to colonial encounters that explore the tensions and conflicts in a hierarchical society with uneven access to power and control (Voss 2008a).

Methodologically speaking, the multi-method approach I used in this dissertation, combining archival, geospatial, architectural, and excavation analyses, presented various themes of data to interpret my research questions. This approach allowed for a number of different patterns to be included and interpreted in this study, providing a more nuanced and complex picture of daily life in a colonial silver refinery. This was especially important as my research focused on an ephemeral, peripheral silver refinery, where historical data was lacking.

The pXRF geochemical study in particular revealed that much can be learned about historic metallurgical activity without having to excavate or expose oneself to toxic heavy metals. My pXRF analysis revealed that the patio process using mercury amalgamation was present in the

Puno Bay by the 17th century. It also revealed hot spots of metallurgical activities which were helpful in determining use of spaces at the site, as well as in determining where to excavate.

I also employed a suite of spatial and statistical analyses to answer my research questions about daily life, control, and surveillance within Trapiche. I champion the use of a combination of analyses, such as multivariate analysis alongside GIS raster hot spot data and chi-square analysis, to interpret multi-variate datasets.

While combining multiple methods helped me better understand daily life within the Trapiche refinery, there are still many unanswered questions. Future directions in the field of colonial archaeology in the Puno Bay should involve larger, wide-scale archaeological surveys of the region, focusing on the identification of colonial material, refineries, mines, and ad-hoc grinding and refining zones. This needs to include an in-depth survey of the area just south of Puno, which is the supposed location of the San Luis de Alba mining seat. Pedestrian survey, combined with geophysical technologies such as ground penetrating radar, pXRF, and soil resistivity/magnetometry, have high potential to reveal the location of this early community, and future investigations in this area would provide much-need information about colonial life prior to the occupation of Puno as a colonial city.

In addition to research near my study location, I suggest future archaeologists look at the larger area of San Antonio de Esquilache to the southwest of Puno, which functioned as an important mining center for over six centuries. Tracking indigenous experiences of labor over time, especially through the Inka, Spanish colonial, and Republican eras, is an important step to understanding how quality of life changed in different social and political settings.

Unregulated refining is not a relic of the colonial past. Unregulated and illegal mining and refining are currently one of the major drivers of environmental degradation around the world and is on the rise globally. However dangerous, it is an important source of income for more than 40 million people today, generating livelihoods, and for some, a pathway out of poverty. As these numbers continue to rise, we need to look to the recent colonial past to better understand the social and economic implications of this industry.

Appendix A Space Syntax Results

In Appendix A, I include the following:

- Figure assessing Trapiche’s site depth, from north to south.
- Figure assessing Trapiche’s mean depth, from north to south.
- Figure assessing Trapiche’s relative asymmetry, from north to south.

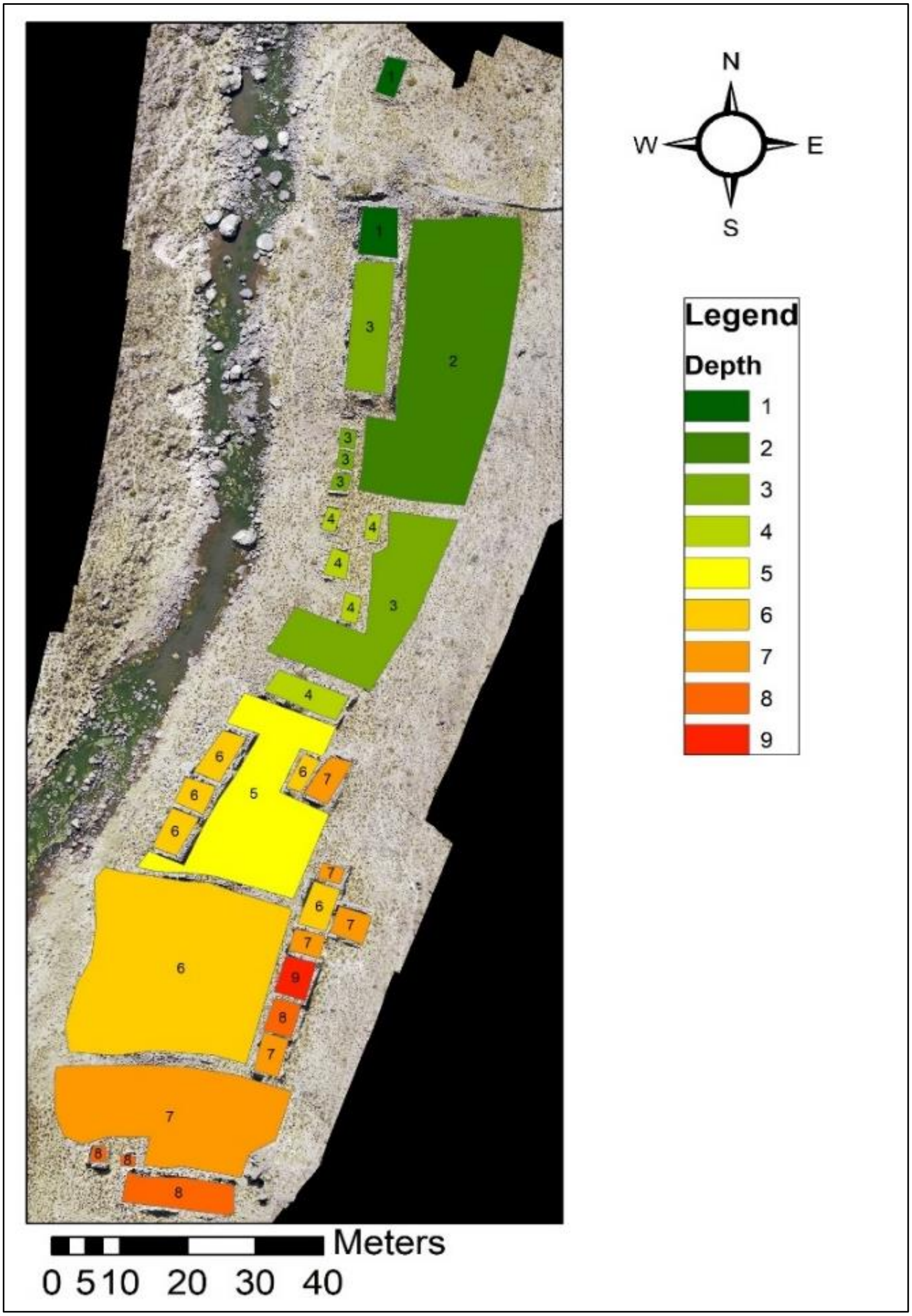

Figure A.1: Trapiche's site depth, from north to south.

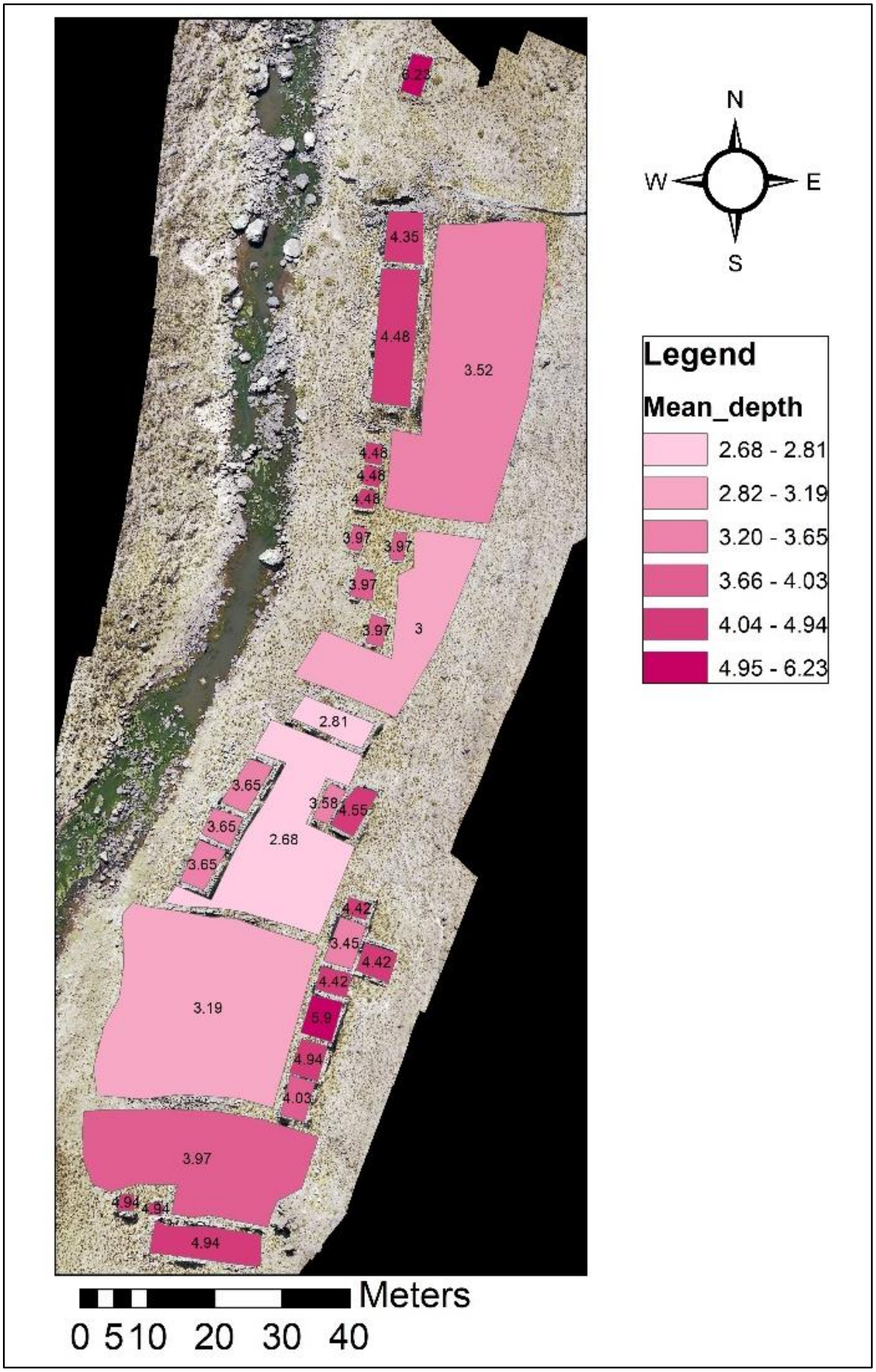

Figure A.2: Trapiche's mean depth, from north to south.

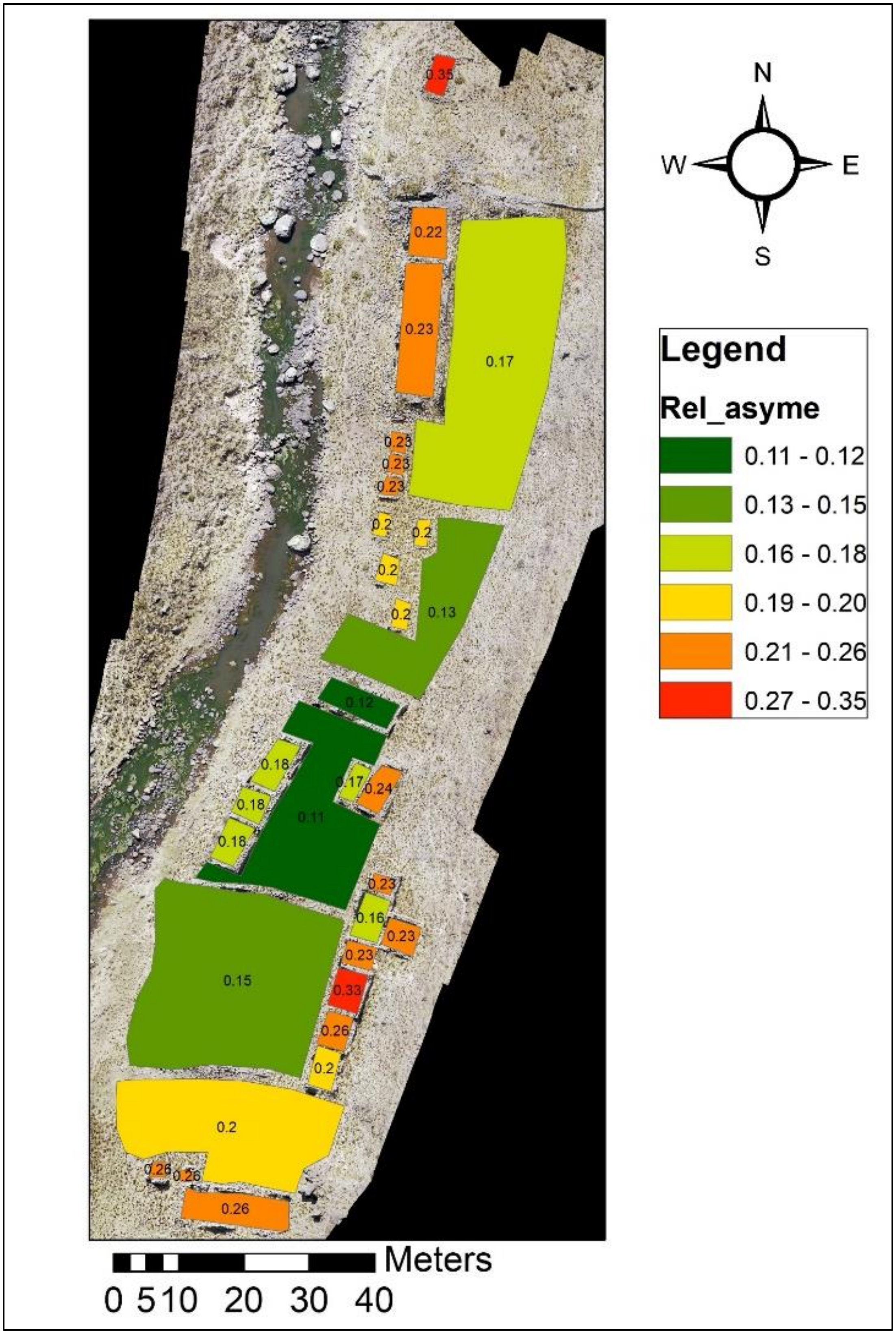

Figure A.3: Trapiche's measure of relative aysmmetry, from north to south.

Appendix B PXRF Results

In Appendix B, I include the following:

- Corrected pXRF values in ppm
- Correct pXRF values for control samples in ppm
- Our risk assessment for excavation in Trapiche soils
- Systat output for our hierarchical cluster analysis of pXRF results
- Systat output for our principal components analysis of pXRF results

Table B.1: Trapiche Corrected pXRF Values in PPM.

Sector	Survey Location	S	K	Ca	Mn	Fe	Cu	As	Ag	Sb	Hg	Pb
A	0A	897	18740	14258	3418	60487	408	160	127	123	4.9	1942
A	1A	237	18946	13102	2435	61444	151	60	20	<LOD[22]	9.5	639
A	2A	253	14244	13418	1475	40261	104	61	38	<LOD	10.9	592
A	3A	298	19523	18980	1500	57165	95	67	32	31	9.9	620
A	4A	238	20448	12829	1240	61878	127	55	32	<LOD	11.7	580
A	5A	202	16657	12936	1352	45635	95	40	26	<LOD	9	557
A	6A	519	14066	11970	1852	40328	126	80	49	<LOD	15.6	956
A	6B	140	16342	8013	886	33952	88	35	22	<LOD	6.3	435
A	5B	427	18147	8953	1572	47846	219	90	58	<LOD	28.2	1121
A	4B	249	19711	9444	1294	45367	131	69	53	<LOD	17.6	783
A	3B	232	20756	8093	1872	43557	169	77	83	<LOD	20.6	979
A	2B	146	17630	7574	1323	29894	113	37	48	<LOD	4.8	626
A	1B	155	17909	8867	993	32041	88	43	24	<LOD	2.5	473
A	0B	609	17228	12090	3666	46445	541	159	180	90	4.6	1774
A	0C	<LOD	7246	3796	462	11423	33	27	<LOD	<LOD	<LOD	89
A	1C	<LOD	11134	4199	575	15905	30	26	13	<LOD	<LOD	100
A	2C	<LOD	11904	4211	519	18667	21	25	<LOD	<LOD	<LOD	57
A	3C	<LOD	13689	5446	613	19927	25	24	<LOD	<LOD	<LOD	70
A	4C	<LOD	17964	8478	802	26930	41	31	13	<LOD	<LOD	209
A	5C	192	16344	12054	1060	27490	74	42	34	<LOD	9.6	494
A	6C	130	18167	7259	955	33327	85	42	23	<LOD	8.2	450
A	7C	121	15321	7493	1017	28366	58	39	12	<LOD	4.5	266
A	7D	<LOD	18106	7983	859	33012	45	30	<LOD	<LOD	4.4	152
A	6D	73	17885	7762	969	35652	44	34	<LOD	<LOD	4.6	149

[22] LOD = level of detection. Every <LOD value was below the level of detection for our pXRF instrument.

A	5D	<LOD	15115	9197	783	25877	43	33	<LOD	<LOD	3.3	183
A	4D	<LOD	13087	5864	796	21833	27	26	<LOD	<LOD	<LOD	105
A	3D	<LOD	12898	5698	820	20980	23	24	<LOD	<LOD	<LOD	69
A	2D	61	15044	7444	749	24941	26	26	<LOD	<LOD	2.1	75
A	1D	<LOD	19106	10914	763	40834	32	27	<LOD	<LOD	<LOD	85
A	0D	<LOD	21758	10105	1323	37794	50	36	<LOD	<LOD	3.4	167
A	mill 3	88	15401	6470	1098	26812	41	33	<LOD	<LOD	<LOD	124
A	mill 2	585	11906	6478	4197	35670	291	636	169	40	24.5	2024
A	mill 1	145	4488	7906	759	9062	35	<LOD	39	<LOD	<LOD	384
A	SM4	<LOD	22044	11408	1898	50329	284	34	<LOD	<LOD	<LOD	102
A	SM1	4368	22736	13084	8091	85922	800	359	459	223	<LOD	7880
A	horno	976	16111	8167	2479	42108	402	176	147	86	38.2	2938
A	SM2	11376	26973	8843	11513	82081	1547	974	698	635	13	16397
B	0C	51	2930	4280	168	7532	30	22	14	<LOD	<LOD	99
B	1A	69	6395	4477	467	11822	69	32	12	<LOD	2.2	219
B	1B	61	13050	7470	914	24960	59	29	13	<LOD	<LOD	169
B	1C	<LOD	15362	6971	444	27507	69	37	13	<LOD	6.3	244
B	2B	317	12881	6260	1431	35525	177	80	49	25	18.5	970
B	2C	793	18253	9769	1509	50813	331	153	90	<LOD	43.3	1726
B	3B	59	15096	9943	708	29768	37	27	17	<LOD	<LOD	107
B	3C	212	18566	9959	1156	42886	141	65	96	32	27.9	765
B	4B	153	12295	7184	650	24014	38	30	<LOD	<LOD	<LOD	110
B	4C	257	16369	9419	1179	37225	127	68	59	<LOD	62.5	885
B	5C	626	11639	9126	1476	31687	262	114	103	37	89.1	1955
B	5B	64	15231	9363	694	28967	28	27	<LOD	<LOD	<LOD	76
B	6C	7240	18852	13851	1860	70908	1287	674	575	291	779	12201
B	6B	284	12148	11214	1077	29282	144	66	39	<LOD	14.9	827
B	7B	223	14005	10107	746	32429	915	48	31	<LOD	27.6	1317
B	7C	459	12094	10708	745	25589	253	55	47	<LOD	22.8	1538
B	8C	318	15093	10745	1155	34700	206	71	48	<LOD	33.3	1131
B	8B	403	5787	12114	1120	13720	94	<LOD	44	<LOD	15.3	603

B	8A	1943	14764	10471	1934	44571	621	273	159	103	361	4681
B	9A	163	17321	8008	956	43031	377	35	14	<LOD	5.8	982
B	9B	4610	16556	9960	3298	78162	2425	699	291	229	418	9076
B	9C	320	12998	9593	658	28665	316	58	34	<LOD	31	1054
B	10C	1864	13611	8729	1848	40347	995	334	244	62	266	4832
B	10B	645	17259	10439	1768	48142	279	140	82	<LOD	64	1754
B	10A	1312	17083	17348	3734	53135	1408	128	36	55	53	4481
B	11A	422	10221	8773	1212	23232	268	85	54	<LOD	30.1	1457
B	11B	772	9948	13788	2573	25668	303	81	61	45	37.6	1652
B	3A	437	15728	10773	1366	40864	275	126	77	41	38.8	1175
B	5A	370	10933	7298	733	25243	290	91	54	<LOD	26.8	916
B	9D	<LOD	8540	6095	525	19271	22	22	<LOD	<LOD	<LOD	61
B	10D	<LOD	1801	4020	397	2891	16	19	13	<LOD	<LOD	27
B	11D	<LOD	10229	9800	519	23065	25	25	<LOD	<LOD	<LOD	73
B	8D	<LOD	10690	9129	600	25690	29	25	<LOD	<LOD	<LOD	59
B	7D	84	15100	11555	976	35263	37	28	<LOD	<LOD	3.2	96
B	7E	<LOD	10628	8949	618	25848	28	25	<LOD	<LOD	<LOD	49
B	5D	<LOD	2938	9671	441	5204	19	19	15	<LOD	<LOD	23
B	3E	169	11266	9005	977	30727	105	47	26	<LOD	62	458
B	3D	226	8254	6908	1198	21274	79	45	28	<LOD	24.4	515
C	0A	2041	12032	8993	2810	49172	1339	373	169	214	93	4749
C	0C	11222	17982	13228	7768	112081	2999	888	225	615	272	10622
C	0D	10272	16671	13074	5761	78854	3822	1051	396	583	556	14923
C	0E	427	9834	9868	1187	28605	167	75	59	23	45.7	1060
C	1G	81	10809	9902	637	29671	37	28	11	<LOD	<LOD	78
C	1F	68	16571	15346	1156	42591	90	38	25	<LOD	19.2	506
C	1E	163	14235	12022	941	35945	88	41	34	<LOD	12	543
C	1D	14565	20124	16364	8913	120631	3302	1245	542	791	698	15960
C	1C	425	13388	12579	1230	37790	318	94	40	30	27.8	1110
C	1B no1	1062	12221	11817	2864	54052	791	267	129	128	182	3461
C	1B no2	751	11113	11626	1559	45584	440	237	80	90	31	1785

C	1A	199	8915	7960	1060	23108	247	72	46	<LOD	36.9	1030
C	2A	1469	15746	10481	1210	49747	610	122	176	156	194	4153
C	2C	233	13155	10983	798	30195	140	33	33	<LOD	21.3	820
C	2D	258	14588	14141	988	42122	143	62	44	<LOD	22.3	865
C	2E	430	14917	14148	1969	43553	234	77	81	34	58.9	1505
C	2F	347	15571	18415	1819	64940	230	76	54	<LOD	57.1	1045
C	datum	169	14483	13857	901	43478	125	53	32	<LOD	25.5	651
C	4D	131	13219	10215	861	32776	91	44	26	<LOD	10	361
C	4C	128	8291	6493	577	18568	71	43	24	<LOD	7.9	353
C	4B	580	8725	7485	1340	33278	332	102	73	39	69.5	2134
C	4A	111	11729	8378	759	27497	76	37	14	<LOD	10	385
C	3D	892	11647	9713	1762	44170	547	190	87	77	105	2738
C	3C	212	6657	6242	478	15525	120	44	31	<LOD	18.7	956
C	3B	63	13061	10756	856	37115	58	32	15	<LOD	12.8	125
N/A	Control 1	130	19342	19953	1184	57378	57	39	<LOD	<LOD	12.6	165
N/A	Control 2	86	17885	10374	1070	51419	98	46	12	<LOD	9	267
N/A	Control 3	<LOD	21104	9769	779	39668	32	27	<LOD	<LOD	3.5	58

Table B.2: Corrected PXRF Values for Control Samples.

Element Name	Symbol	Control 1 (ppm)	Control 2 (ppm)	Control 3 (ppm)	Average (ppm)
Sulfur	S	130	86	<LOD[23]	72
Chlorine[24]	Cl	<LOD	<LOD	<LOD	<LOD
Potassium	K	19,342.00	17,885.00	21,104.00	19,443.70
Calcium	Ca	19,953.00	10,374.00	9,769.00	13,365.30
Manganese	Mn	1,184.00	1,070.00	779	1,011.00
Iron	Fe	57,378.00	51,419.00	39,668.00	49,488.30
Copper	Cu	98	57	32	62.3
Arsenic	As	46	38	26.5	36.8
Silver	Ag	<LOD	12	<LOD	4
Antimony	Sb	<LOD	<LOD	<LOD	<LOD
Mercury	Hg	12	9	3.5	8.2
Lead	Pb	165	267	58	163.3

[23] Below level of detection.
[24] Chlorine values were not factor corrected.

Table B.3: Risk Assessment for Heavy Metals in Trapiche Soils.

Element Name	Symbol	Negative Heath Effects from Long-Term Exposure[25]	Safe Soil Levels[26] (mg/kg)	Highest Trapiche Soil Levels (mg/kg)	Total Risk[27] Without PPE	Total Risk with PPE
Manganese	Mn	Neurological and respiratory effects; nervous system damage	11,600.0	11,513.0	0.09	0.09
Copper	Cu	Skin and respiratory effects; nausea; liver and kidney damage	5,310.0	3,822.0	0.07	0.07
Arsenic	As	Skin and lung irritation; nervous system damage; cancer	218.0	**1,245.0**	0.57	0.40
Silver	Ag	Skin discoloration; lung and throat irritation	2,650.0	698.0	0.02	0.02
Antimony	Sb	Vomiting; stomach ulcers; eye irrigation; lung and heart damage	212.0	**791.0**	0.37	0.37
Mercury	Hg	Brain and nervous system damage; kidney and lung damage	21.0	**779.0**	**3.76**	0.01
Lead[28]	Pb	Developmental defects; damage to multiple organs; possible death	800.0	**16,397.0**	**91.53**	0.01
Totals					**96.42**	**0.97**

Table B.4: Hierarchical Cluster Analysis, Distant Metric 1, Pearson Correlation Coefficient, Complete Linkage Method (Farthest Neighbor).

Clusters Joining	Clusters Joining	At Distance	Number of Members
Sb	S	0.016	2
Pb	As	0.051	2
Pb	Cu	0.095	3
Ag	Mn	0.167	2
Ag	Sb	0.204	4
Fe	Pb	2.55	4
Fe	Hg	3.68	5
Ca	K	0.559	2
Ag	Fe	0.618	9
Ag	Ca	0.861	11

[25] U.S. Agency for Toxic Substance and Disease (ATSDR).
[26] Regional Screening Levels (RSL) for risk assessment were determined using the EPA's RSL Calculator.
[27] Total Risk, or the Hazard Index (HI), was determined using the RSL Calculator. Values less than 1 indicate no adverse health effects.
[28] Lead risk was calculated using blood-lead levels with the EPA's Adult Lead Methodology (AML) Risk Calculator.

Table B.5: PCA of PXRF, Component Loadings 1-4.

Element	1	2	3	4
S	0.984	0.048	0.006	0.068
PB	0.974	0.126	0.029	-0.084
SB	0.972	0.041	-0.051	0.146
AS	0.950	0.210	0.029	0.082
FE	0.929	-0.201	0.034	0.120
CU	0.893	0.044	0.257	0.257
AG	0.880	0.204	-0.128	-0.362
MN	0.853	0.008	-0.419	0.247
HG	0.713	0.106	0.615	-0.299
K	0.671	-0.399	-0.472	-0.353
CA	0.283	-0.903	0.262	0.044

Appendix C Unit Summaries

In Appendix C, I include the following:

- Descriptions of every excavated unit
- Dimensions and locations of every excavated unit
- Tables that list every locus and stratigraphic level in every excavated unit

Unit 1, Sector A

Dimensions: Test unit 1m x 1m.

Location: UTM (WGS 84) 388067.41 E, 8234884.51 N.

Description: Sector A, Patio 1, next to the mill.

Was not excavated due to the high level of heavy metal concentration.

Unit 2, Sector A

Dimensions: Test unit 1m x 1m.

Location: UTM (WGS 84) 388067.02 E, 8234871.11 N.

Description: Sector A, Patio 1, next to the mill.

Was not excavated due to the high level of heavy metal concentration.

Unit 3, Sector A

Dimensions: Test unit 1m x 1m.

Location: UTM (WGS 84) 388056.44 E, 8234855.28 N.

Description: Sector A, Patio 2, south of the mill.

Was not excavated due to the high level of heavy metal concentration.

Unit 4, Sector A

Dimensions: Test unit 1m x 1m.

Depth: 84 cm.

Location: UTM (WGS 84) 388059.06 E, 8234836.68 N.

Description: Sector A, Patio 2, near Sector A households.

Declared Loci: 105, 107, 109, 111, 113, 115, 117, 118.

Table C.1: Unit 4 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
105	Surface	No	A	A	0
107	Surface	No	A	A	0
109	Surface	No	A	A	0
111	Surface	No	A	A	0
113	Surface	No	A	A	0
115	Fill	Yes	B	A	0
117	Clay	No	C	A	0
118	Sterile	No	D	A	0

Unit 4 was a small test unit placed east of the Sector A structures, in an outdoor patio area, to learn about domestic activities that took place outside of these structures. This unit was not expanded past the initial 1m x 1m test pit. Unit 4 had four separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included loci 105, 107, 109, 111, and 113. These were grouped as the surface soil, with a dark brown color, sandy texture, semi-compact nature, with numerous roots and small rocks. This context was excavated to a depth of 49 cm. We did not find any cultural material in this context. The large amount of surface soil may have been due to the location of the unit near a steep hill, with soil accumulating due to erosion.

Context B differed from Context A as the soil texture changed, becoming very loose and soft. This context included Locus 115 and is designated as fill in preparation of the patio. It was dark brown in color, sandy texture, soft and loose, with gravel. It was excavated to 60 cm. It included colonial ceramics and remains of animal bones.

Context C was orange soil, very hard and full of clay. This included Locus 117. The color was orange-brown, compact, and included clay and rocks. We excavated this to 73 cm. We did not find any cultural material. Context D included Locus 118 and was a sterile unit. Soil did not include clay. It was brown in color, sandy, with gravel. We excavated this to 84 cm. Due to lack of material, we decided not to expand this unit.

Unit 9, Sector A

Dimensions: Test unit 1m x 1m.

Depth: 49 cm.

Location: UTM (WGS 84) 388049.86 E, 8234847.56 N.

Description: Sector A, inside Structure 7.

Declared Loci: 046, 048, 052, 054, 057, 060, 063.

Table C.2: Unit 9 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
046	Surface	No	A	A	0
048	Surface	Yes	A	A	0
052	Surface	Yes	A	A	0
054	Surface	Yes	A	A	0
057	Floor	Yes	B	A	0
060	Fill	Yes	C	A	0
063	Sterile	No	D	A	0

Unit 9 was a small test unit placed inside Structure 7, one of the small structures in Sector A. This was placed here to learn about domestic activities that took inside Sector A households. This unit was not expanded past the initial 1m x 1m test pit. Unit 9 had four separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A was the surface soil, and included Loci 046,048, 052, and 054. The soil was dark brownish red, with a loamy, loose texture, with many roots and small rocks. The only artifacts encountered were ceramics, with many of them painted, and a high proportion were serving plates. This was excavated to 32 cm.

Context B included Locus 057 and appeared to have been a compact earthen floor. The soil was dark brown and was very compact with clay inclusions. We found a lot of carbonized plant material, but very few remains. We excavated through the floor, until 37 cm. Context C included Locus 060 and was likely fill built to support the earthen floor. The color of this soil was reddish brown, with very sandy texture, and many inclusions of gravel and small pebbles. There were very few materials, and we excavated to 42 cm. Context D included Locus 163 and was a sterile layer of dark reddish brown soil. We ended at 49 cm.

Unit 10, Sector A

Dimensions: Test unit 1m x 1m.

Depth: 71 cm.

Location: UTM (WGS 84) 388051.0 E, 8234840.44 N.

Description: Sector A, inside Structure 9.

Declared Loci: 061, 062, 067, 071, 073, 076, 080.

Table C.3: Unit 10 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
061	Surface	No	A	A	0
062	Surface	Yes	A	A	0
067	Collapse	Yes	B	A	0
071	Collapse	No	B	A	0
073	Floor	Yes	C	A	0
076	Floor	Yes	C	A	0
080	Sterile	No	D	A	0

Unit 10 was a small test unit placed inside Structure 9, one of the small structures in Sector A. This was placed here to learn about domestic activities that took inside Sector A households. This unit was not expanded past the initial 1m x 1m test pit. Unit 10 had four separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Loci 061 and 062. This was the surface soil, colored dark brown, with a sandy, semi-compact texture, and many roots and gravel inclusions. We found very little material and dug until 19 cm. Context B included wall collapse, as this unit was placed near the inside of Structure 9's interior wall. This contained Loci 067 and 071. The soil was a dark brown, with a clay-like texture, and small gravel inclusions. There were many large rocks from the wall collapse. In between the collapsed wall, we did find a few fragments of colonial painted pottery, mostly plates, similar to those found in Unit 9. We excavated until 36 cm.

Context C included Loci 073 and 076. Both contexts included the same dirt living floor, very compact and full of clay inclusions. Within these loci, we uncovered very few small pieces of broken ceramics. We excavated until 56 cm. Context D was directly below the living floor and included Locus 080, which was reddish brown soil and sandy. There were no artifacts in this level. We excavated until 71 cm.

Unit 11, Sector A

Dimensions: Expanded Unit, 2m x 2m.

Depth: 65 cm.

Location: UTM (WGS 84) 388051.57 E, 8234855.87 N

Description: Sector A, inside Structure 5.

Declared Loci: 065, 068, 070, 074, 075, 077, 078, 081, 082, 085, 087, 089, 095, 098, 099, 101, 103, 110, 112, 114, 116, 124.

Table C.4: Unit 11 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
065	Surface	No	A	A	0
068	Collapse	Yes	B	A	0
070	Collapse	No	B	A	0
074	Kitchen	Yes	C	A	0
075	Kitchen	Yes	C	A	0
077	Floor	Yes	D	A	0
078	Stone Floor	Yes	E	A	0
081	Surface	No	A	A	2
082	Surface	No	A	A	2
085	Collapse	Yes	B	A	2
087	Collapse	Yes	B	A	2
089	Floor	Yes	D	A	2
095	Surface	No	A	A	1
098	Collapse	Yes	B	A	1
099	Kitchen	Yes	C	A	1
101	Floor	Yes	D	A	1
103	Stone Floor	Yes	E	A	1
110	Surface	No	A	A	3
112	Collapse	No	B	A	3
114	Collapse	No	B	A	3
116	Stone Floor	Yes	E	A	3
124	Hearth	Yes	F	A	2

Unit 11 began as a small test unit (Cuad 0) placed inside Structure 5, one of the small structures in Sector A. It was later expanded to 2m x 2m, with 4 separate quads. This unit was placed in Structure 5 to learn about domestic activities that took inside Sector A households. Unit 11 had six separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Loci 066, 081, 082, 095, and 110. These were all part of the surface soil, and had a dark brown color, sandy texture, with many inclusions of gravel and roots. None of these Loci had any cultural material. The surface context was excavated until 22 cm.

Context B included Loci 068, 070, 085, 087, 098, 112, and 114. This context was wall collapse and included very large rocks from Structure 5's walls. The soil was dark brown, semi-compact, with inclusions of gravel and pebbles from the wall. We uncovered very few artifacts from this collapse, although some lithic tools were uncovered, as well as the stone llama figurine.

This figurine might have been deposited at the very end of the site's occupation, as a way to ceremonially "close" the structure. We excavated until 32 cm.

Context C was below the wall collapse and appears to have been remains from food preparation, sitting on top of the living floor (Context D). The color of Context C soil was reddish brown, with sandy-clay inclusions. We found many charcoal fragments, as well as many pieces of ceramics, lithics, metals, animal bones, and burned clay. We excavated until 39 cm.

Context D was directly below the food preparation level, and was likely the compact, dirt living floor of the structure. This included Loci 077, 089, and 101. The color of the soil was dark reddish brown, semi-compact, with many gravel inclusions. We found many artifacts flat on a level surface. This included ceramics and a spindle whorl. We excavated to 48 cm.

Context E included Loci 078, 103, and 116. This was a stone-lined floor. The soil in between the stones was compact with gravel. On top of and between the stones, we found small lithic fragments and debitage, as well as a small bead. We did not remove the stones from the floor. We excavated until 51 cm.

Context F (Locus 124) was a small hearth located in Cuad 2, in the northeast corner of the structure. The color of the soil in this feature was dark brown, with a loamy texture, with many inclusions of charcoal. Inside this small hearth, we found many burnt remains. We excavated the hearth until 65 cm and did not excavate below this level due to lack of time.

Unit 12, Sector A

Dimensions: Test unit 1m x 1m.

Depth: 90 cm.

Location: UTM (WGS 84) 388053.96 E, 8234834.08 N.

Description: Sector A, inside Structure 10.

Declared Loci: 064, 066, 069, 072, 079/097, 100, 102, 104, 106, 108.

Table C.5: Unit 12 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
064	Surface	No	A	A	0
066	Surface	No	A	A	0
069	Collapse	No	B	A	0
072	Collapse	Yes	B	A	0
079/097	Collapse	No	B	A	0
100	Below Collapse	No	C	A	0
102	Below Collapse	Yes	C	A	0
104	Floor	Yes	D	A	0
106	Fill	Yes	E	A	0
108	Sterile	No	F	A	0

Unit 12 was a small test unit placed inside Structure 10, one of the small structures in Sector A. This was placed here to learn about domestic activities that took inside Sector A households. This unit was not expanded past the initial 1m x 1m test pit. Unit 12 had six separate contexts, among various nature strata and arbitrary levels (identified as loci). Context A included Loci 064 and 066, which were part of the surface soil. This was dark reddish brown in color, with a sandy texture and many roots and gravel inclusions. There were no artifacts in these loci. We excavated until 15 cm.

Context B was the wall collapse from Structure 10's walls. This included Loci 069, 072, 079, and 097. The color of the soil was dark brown, with a loamy, loose texture, with many inclusions of gravel. There were also very large rocks from the collapsed wall. In between the rocks and wall collapse, we uncovered a few ceramic fragments. We excavated until 46 cm.

Context C included Loci 100 and 102. These were natural strata below the collapsed rock wall, and likely indicate accumulation of debris after the site was abandoned, but before the rock wall collapsed. The soil was dark brown, loose, and loamy, and there were no rocks from collapse. There were no artifacts in Locus 100, and only two small ceramic fragments in Locus 102. We excavated until 62 cm.

Context D (Locus 104) was the living surface of Unit 12, which was a dirt compacted floor. The color of the soil was reddish brown, semi-compact, with charcoal inclusions. We found various artifacts flat on this surface, including ceramics and burned camelid dung. Context E (Locus 106) was located below the living floor and appears to have been some type of fill (possibly used to support and construct the living floor). The soil was very dark brown/black, very sandy, and very loose. We did not find many artifacts in this level. We excavated until 78 cm BD. Context F (Locus 108) was the final, sterile level below the occupation level. The color of the soil was greyish red and was very compact. We excavated until 90 cm.

Unit 5, Sector B

Dimensions: Test unit 1m x 1m.

Location: UTM (WGS 84) 388043.95 E, 8234809.69 N.

Description: Sector B, Patio 3, central patio of site.

Was not excavated due to the high level of heavy metal concentration.

Unit 6, Sector B

Dimensions: Test unit 1m x 1m

Depth: 49 cm.

Location: UTM (WGS 84) 388039.1 E, 8234796.74 N.

Description: Sector B, Patio 3, outside of Structure 15.

Declared Loci: 121, 123, 127, 130, 133, 134, 137.

Table C.6: Unit 6 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
121	Surface	No	A	B	0
123	Surface	Yes	A	B	0
127	Collapse	No	B	B	0
130	Collapse	Yes	B	B	0
133	Fill	No	C	B	0
134	Clay	Yes	D	B	0
137	Sterile?	No	E	B	0

Unit 6 was a small test unit placed east Structure 15 in Sector B, in the outdoor patio area of Sector B. It was placed there to learn about domestic activities that took place outside of Sector B structures. This unit was not expanded past the initial 1m x 1m test pit. Unit 6 had five separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Loci 121 and 123. They were both part of the surface soil, which was dark brown, silty, and smooth with many roots. This was excavated to 20 cm. Only one ceramic fragment was found. Context B included wall collapse from Structure 15. This context included Loci 127, 130, and 137. This was full of large rocks from the wall, including small gravel. The color of the soil was dark brown, full of clay and other inclusions. This was excavated to 40 cm BD. Again, we found little material. Context C (Loci 133) was a small area of fill that was not excavated due to time restraints.

Context D (Loci 134) was a level of dark red clay. The soil was compact, with inclusions of wood and grass. This was possibly part of the plaster covering of the wall before it collapsed. This context included ceramics, animal bones, and pieces of clay. It was excavated to 43 cm. Context E (Loci 137) began under the small clay layer. This was yellow brown earth with no cultural material and was likely sterile. It was excavated to 49 cm. We ended excavations and did not expand this unit due to lack of cultural material.

Unit 7, Sector B

Dimensions: Test unit 1m x 1m.

Depth: 52 cm.

Location: UTM (WGS 84) 388040.07 E, 8234785.18 N.

Description: Sector B, Main Patio (Patio 4).

Declared Loci: 131, 135, 136, 141, 145.

Table C.7: Unit 7 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
131	Surface	Yes	A	B	0
135	Ash layer	No	B	B	0
136	Dark soil/Fill?	No	C	B	0
141	Dark soil/Fill?	No	C	B	0
145	Sterile	No	D	B	0

Unit 7 was a small test unit placed in the main metallurgical patio of Sector B. It was placed there to learn about open patio activities that took place in this area. This unit was not expanded past the initial 1m x 1m test pit. Unit 7 had four separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Locus 131, which was the surface soil. This soil was reddish brown with sandy, compact texture, including many rocks and gravel. There were few artifacts found in this context – only a few ceramic fragments. This was excavated until 14 cm. Context B, with Locus 135, we immediately below Locus 131, and was a thin ash layer across the entire unit. This was reddish grey in color, with very soft, sandy text. It was only 1 cm thick, and was excavated until 15 cm. There was no cultural material in this ash lens.

Context C, including Loci 136 and 141, was directly below the ash layer. The soil was dark reddish brown, with more inclusions of rock and gravel. There was not cultural material. It may have been part of a prepared patio area and/or a platform for refining work, given the large amount of gravel. We excavated until 35 cm BD. Context D, with Locus 145, appeared to be natural, sterile ground below the fill platform. The soil was dark red, with clay inclusions. We excavated until 52 cm BD. We did not find any cultural material.

Unit 8, Sector B

Dimensions: Test unit 1m x 1m.

Depth: 44 cm.

Location: UTM (WGS 84) 388026.9 E, 8234786.48 N.

Description: Sector B, Main Patio (Patio 4). Mercury Oven.

Declared Loci: 147, 151, 153, 157, 160.

Table C.8: Unit 8 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
147	Surface	Yes	A	B	0
151	Burned clay	Yes	B	B	0
153	Wall	-	-	B	0
157	Ash layer	Yes	C	B	0
160	Bottom of oven		D	B	0

Unit 8 was a small test unit placed in the main metallurgical patio of Sector B. It was placed there to learn about open patio activities that took place in this area. This unit was not expanded past the initial 1m x 1m test pit due to time constraints. Unit 8 had four separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A contained Locus 147, and surface soil. The soil was dark grey, with a sandy, loose texture with inclusions of roots and gravel. We found a large collection of ceramics, animal bones, and large pieces of burned clay. We also uncovered burned camelid dung in this layer. These remains indicated there was likely an oven or hearth directly below this surface layer. We dug until 14 cm.

Context B uncovered the wall of the oven. It also corresponded with a change in soil color and texture. The soil was reddish brown, with orange clay. There were many inclusions of burnt clay, along with burnt ceramics, and pieces of burnt bricks. This was excavated to 25 cm. Locus 157 was the oven wall itself, and it was given a separate Locus number. Context C appeared directly below B and was an ash lens. The soil color was dark grey, with a very sandy texture, compact, with many inclusions of burnt soil and burnt clay. There were many fragments of mercury pot rims, bricks, clay, and carbonized wood. This was excavated to 36 cm.

Context D included Locus 160. This was the bottom of the oven, on top of the stone floor of the oven. The soil was dark black, with a fine and sandy texture, with many ash inclusions. This layer also included many ceramic fragments, as well as animal bones and burned clay. At the bottom of this context, we encountered a stone-lined floor, and ended excavation. We excavated to 43 cm.

Unit 14, Sector B

Dimensions: Expanded unit, 1m x 2m.

Depth: 79 cm.

Location: UTM (WGS 84) 388054.07 E, 8234807.3 N.

Description: Sector B, inside Structure 17. Possible oven.

Declared Loci: 166, 168, 170, 172, 173, 179, 217, 220, 223, 227, 230.

Table C.9: Unit 14 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
166	Surface	Yes	A	B	0
168	Surface	Yes	A	B	0
170	Collapse	Yes	B	B	0
172	Burning	Yes	C	B	0
173	Burning	Yes	C	B	0
179	Sterile	No	E	B	0
217	Surface	Yes	A	B	1
220	Collapse	Yes	B	B	1
223	Burning	Yes	C	B	1
227	Burning	Yes	C	B	1
230	Activity zone?	Yes	D	B	1

Unit 14 began as a small test unit (Cuad 0) placed inside Structure 17, a large structure inside Sector B. It was later expanded to 1m x 2m, with 2 separate quads. This unit was placed in Structure 17 to learn more about activities in Sector B. Unit 14 had five separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Loci 166, 168, and 217. These were surface soils, dark reddish brown in color, sandy with clay, with many roots, gravel, and small rocks. A few ceramics were found in the surface levels. We excavated until 23 cm. Context B included Loci 170 and 220, and were portions of wall collapse, including large rocks from the walls. The soil continued to be dark reddish brown, but was semi-compact, with lots of clay and plaster inclusions. Ceramics and burned clay were found within the wall collapse. We excavated until 32 cm.

Context C included Loci 172, 173, 223, and 227. This was directly below the collapse and was likely the last occupation of the structure. The soil was dark brownish black, with very sandy loose texture, and many gravel inclusions. It appeared to be a fill event, with many burnt artifacts and charcoal. We recovered ceramics, lithics, animal bones, clay, and camelid dung and excavated this burnt fill until 72 cm.

Context D was Locus 230 and was only present in Cuad 1. It was possibly the living floor of the structure, as many artifacts were found flat in the soil. It may also have been an oven of some sort since much of the material was burned. The soil was a dark brownish grey, with many inclusions of ash and charcoal. Again, we found many pieces of ceramics, animal bones, charcoal, and burnt camelid dung. We excavated this to 37 cm and were unable to excavate more due to lack of time and funds. Context E was the final context and included Locus 179. This was sterile soil in Cuad 0, below the fill. It was compact, reddish brown, with many small stones and gravel. We did not find any artifacts and excavated until 79 cm.

Unit 15, Sector B

Dimensions: Test Unit 1m x 1m.

Depth: 70 cm.

Location: UTM (WGS 84) 388036.01 E, 8234810.73 N.

Description: Sector B, inside Structure 13. Possible administrative building.

Declared Loci: 049, 051, 053, 055, 056, 058, 059, 083, 084.

Table C.10: Unit 15 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
049	Surface	Yes	A	B	0
051	Surface	No	A	B	0
053	Surface	Yes	A	B	0
055	Fill	Yes	B	B	0
056	Living Floor	Yes	C	B	0
058	Prepared floor/platform	Yes	D	B	0
059	Cut	Yes	E	B	0
083	Sterile	No	F	B	0
084	Sterile	No	G	B	0

Unit 15 was a small test unit placed inside Structure 13, a large structure inside Sector B. This unit was placed in Structure 13 to learn more about activities in Sector B. Unit 15 had seven separate contexts, among various nature strata and arbitrary levels (identified as loci). Context A was the surface soil and contained Loci 049, 051, and 053. The soil was a dark brown color, loamy, semi-compact, with many inclusions of roots, gravel, and small rocks. We uncovered very few artifacts in this level and excavated until 28 cm. Context B was Locus 055 and appeared to have been a type of fill event, or the last occupation event of the site. The soil was dark brown, semi-compact, with many clay inclusions. We uncovered ceramics and animal bones. We excavated until 36 cm.

Context C was Locus 056 and was likely a compacted, dirt floor. The soil was dark brown, loamy, compact, and had many inclusions of clay and charcoal. There were also ceramics and animal bones lying flat horizontally. This living floor was not very deep, and we excavated until 42 cm. Below the floor was Context D/Locus 058. This was likely a prepared fill to even out the ground to have a flat floor. The soil was dark brown, compact, and had many rock inclusions. There were small artifact fragments among this prepared fill. We excavated to 55 cm.

Context E/Locus 059 was a cut or possible post hole in the northeast corner of the unit/Structure 13. This feature was round, small, and included very sandy, loose soil with some gravel and only 1 ceramic fragment. This was excavated 52 cm. Context F/Locus 083 was below the prepared floor platform (Locus 058) and was reddish yellow in color, sandy, loose, with gravel. There was no material. Context G/Locus 084 was also lacking artifacts and was sterile. Soil color was dark brown, semi-compact, and slightly sandy. We excavated until 70 cm.

Unit 16, Sector B

Dimensions: Expanded 1m x 2m unit.

Depth: 50 cm.

Location: UTM (WGS 84) 388030.56 E, 8234797.55 N.

Description: Sector B, inside Structure 15. Possible administrative building.

Declared Loci: 086, 088, 090, 091, 092, 093, 094, 096, 119.

Table C.11: Unit 16 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
086	Surface	No	A	B	0
088	Collapse	Yes	B	B	0
090	Collapse	Yes	B	B	0
091	Floor	-	D (not excavated)	B	0
092	Surface	No	A	B	1
093	Wall	-	E (not excavated)	B	1
094	Collapse	Yes	B	B	1
096	Collapse	Yes	B	B	1
119	Red plaster	Yes	C	B	1

Unit 16 was a test unit placed inside Structure 15, a large structure inside Sector B. This unit was placed in Structure 15 to learn more about activities in Sector B. It was later extended to include the doorway into Structure 15, as we uncovered red plaster floor and steps leading into the build. Unit 16 had five separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Loci 086 and 092 and was the surface soil. There were not artifacts. The soil was reddish brown, sandy, loose, with many roots and gravel. We excavated until 23 cm. Context B included Loci 088, 090, 094, and 096. These were part of the collapse event of the structure, with large rocks from the walls mixed with soil. The soil was dark reddish brown, semi-loose, and included some small fragments of ceramics and metals. We found a musket ball in Cuad 1, near the doorway, in this context. We excavated until 46 cm.

Context C/Locus 119 was the red plaster mixed with soil that was immediately above the living floor and stairs. It was dark red, with clay, and compact. There were many artifacts, such as ceramics, nails, and animal bones. We excavated until the floor and stairs were visible, until 50 cm. Due to time constraints, we did not excavate further.

Unit 17, Sector B

Dimensions: Expanded 1m x 2m unit.

Depth: 75 cm.

Location: UTM (WGS 84) 388059.75 E, 8234785.37 N.

Description: Sector B, inside Structure 20. Possible administrative building.

Declared Loci: 004, 005, 007, 009, 011, 012, 015, 018, 021, 025, 199, 201, 205, 207.

Table C.12: Unit 17 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
004	Surface	No	A	B	0
005	Surface	No	A	B	0
007	Collapse	No	B	B	0
009	Collapse	Yes	B	B	0
011	Collapse	Yes	B	B	0
012	Collapse	Yes	B	B	0
015	Collapse	Yes	B	B	0
018	Plaster Floor	Yes	C	B	0
021	Prepared floor/platform	Yes	D	B	0
025	Sterile	No	E	B	0
199	Surface	No	A	B	1
201	Surface	No	A	B	1
205	Collapse	Yes	B	B	1
207	Collapse	Yes	B	B	1

Unit 17 was a test unit placed inside Structure 20, a large structure inside Sector B. This unit was placed in Structure 20 to learn more about activities in Sector B. It was later extended to include the doorway into Structure 20. Unit 17 had five separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Loci 004, 005, 201, and 205. These were all part of the surface soil. There were no artifacts found. The soil was dark brown, loamy sand, loose, with many roots and gravel. We dug to 15 cm. Context B included Loci 007, 009, 011, 012, 015, 205, and 207. This was the wall collapse of the building, with many large rocks. The soil was dark reddish brown, semi-compact, with many inclusions of small gravel and white plaster from the wall itself. There were many artifacts mixed with the wall collapse, including animal bones, ceramics, nails, clay, and plaster. We dug until 52 cm.

Context C/Locus 018 was the white plaster floor, directly below the collapse of the wall. The soil was brownish red with white inclusions and spots, many clay inclusions, semi-compact, and 50% white plaster. The floor itself had very few artifacts – just one animal bone. This was dug until 55 cm. Context D/Locus 021 was below the plaster floor and appears to have been a type of fill used to flatten and prepare the plaster floor. It was dark greyish brown, semi-compact, with many small rocks and lots of gravel. There was only 1 ceramic found here. We dug until 65 cm. Context E/Locus 025 was sterile soil below the prepared fill, brownish red, clay, semi-compact, and no artifacts. We dug until 75 cm.

Unit 18, Sector B

Dimensions: Test Unit 1m x 1m.

Depth: 76 cm.

Location: UTM (WGS 84) 388052.82 E, 8234782.84 N.

Description: Sector B, inside Structure 21. Possible administrative building.

Declared Loci: 017, 019, 020, 022, 023, 024, 026, 027, 029.

Table C.13: Unit 18 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
017	Surface	Yes	A	B	0
019	Surface	Yes	A	B	0
020	Collapse	Yes	B	B	0
022	Collapse	Yes	B	B	0
023	Soil with Plaster	Yes	C	B	0
024	Mud/Clay	Yes	D	B	0
026	Plaster Floor	No	E	B	0
027	Prepared platform?	Yes	F	B	0
029	Sterile	No	G	B	0

Unit 18 was a test unit placed inside Structure 21, a structure inside Sector B. This unit was placed in Structure 21 to learn more about activities in Sector B. Unit 18 had seven separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Locus 017 and 019. These were part of the surface soil, which was dark brown, sandy, semi-compact, and had a lot of roots and small rock. Some clay and ceramics were found in these loci. These were excavated 19 cm. Context B included Loci 021 and 022. This was the rock wall collapse. The soil was yellowish brown, sandy with clay, semi-compact, with gravel and plaster inclusions. There was very little material in this collapse – a few ceramics and animal bones. This was excavated until 39 cm.

Context C/Locus 023 was directly below the collapse and was a mix of soil and plaster pieces. It was dark brown, sandy, semi-compact, with fragments of plaster. It was excavated until 47 cm. Context D/Locus 024 was a small locus, apparently a mud brick or piece of mud/clay that fell from the wall or roof of the structure on top of the living floor. It was yellowish brown, clay, and compact. It contained small animal bones. This was excavated until 52 cm.

Context E/Locus 026 was the plaster living floor directly below the mud. This was a white, prepared plaster floor, very clay-like, compact, with plaster and gypsum. There was no cultural material embedded in the floor. This was a very thin level and was excavated until 55 cm. Context F/Locus 027 was below the plaster floor and appeared to be a prepared platform to put the white plaster on top of. It was brownish yellow, clay-like, with gravel, and semi-compact. There were very few artifacts and we excavated until 65 cm. Context G/Locus 029 was likely sterile, as we did not find any cultural material. The soil was dark brownish yellow, sandy, and semi compact. We excavated until 76 cm.

Unit 19, Sector B

Dimensions: Expanded 1m x 3m unit.

Depth: 77 cm.

Location: UTM (WGS 84) 388048.34 E, 8234765.46 N.

Description: Sector B, inside Structure 24. Possible overseer house.

Declared Loci: 001, 002. 003. 006, 008, 010, 013, 014, 016, 031, 033, 037, 039, 042, 045, 139, 142, 144, 146, 150, 155.

Table C.14: Unit 19 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
001	Surface	Yes	A	B	0
002	Surface	Yes	A	B	0
003	Collapse	Yes	B	B	0
006	Collapse	No	B	B	0
008	Collapse	Yes	B	B	0
010	Collapse	Yes	B	B	0
013	Midden	Yes	C	B	0
014	Midden	Yes	C	B	0
016	Floor		D	B	0
031	Surface	Yes	A	B	1
033	Collapse	Yes	B	B	1
037	Collapse	Yes	B	B	1
039	Midden	Yes	C	B	1
042	Midden	Yes	C	B	1
045	Floor		D	B	1
139	Surface	Yes	A	B	2
142	Collapse	Yes	B	B	2
144	Collapse	Yes	B	B	2
146	Collapse	Yes	B	B	2
150	Midden	Yes	C	B	2
155	Floor		D	B	2

Unit 19 was a test unit placed inside Structure 24, a higher-status structure inside Sector B. This unit was placed in Structure 24 to learn more about activities in Sector B, as well as to learn if it was the residence of an overseer. It was later expanded until a 1 x 3 m unit. Unit 19 had four separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Loci 001, 002, 031, and 139. All were part of the surface soil, with brown color, sandy clay texture, loose, with roots and rocks. There were a few ceramics mixed with the surface soil. We dug to 11 cm. Context B included Loci 003, 006, 008, 010, 033, 037, 142, 144, and 146. This was wall collapse, with large rocks. The soil was brown, sandy with clay, semi-loose, with plaster and gravel inclusions. There were ceramics scattered through the rock debris. We dug until 40 cm.

Context C included Loci 013, 014, 039, 042, and 150. This was a midden or trash refuse left on the surface of the living floor. The soil color was brown, with clay, semi-compact, with many food remains, including animal bones, ceramics, metals, lithics, and personal items. We excavated until the floor, which was 63 cm.

Context D included Locus 016, 045, and 155. This was the compacted, dirt living floor. The soil was dark reddish brown, loamy with clay, very compact, with charcoal and clay inclusions. Imbedded in the floor were ceramic fragments, lithics, and animal bones. We dug until 77 cm, and because of time constraints, did not dig below the floor.

Unit 13, Sector C

Dimensions: Expanded Unit, 2m x 2m.

Depth: 59 cm.

Location: UTM (WGS 84) 388027.04 E, 8234746.29 N.

Description: Sector C, inside Structure 27 (the chapel).

Declared Loci: 215, 216, 219, 221, 225, 243, 226, 229, 231, 232, 233, 236, 239, 241, 242, 234, 235, 237, 238, 240.

Table C.15: Unit 13 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
215	Surface	Yes	A	C	0
216	Surface	Yes	A	C	0
219	Collapse	Yes	B	C	0
221	Collapse	Yes	B	C	0
225	Stone Floor	-	D	C	0
243	2nd Floor	Yes	E	C	0
226	Surface	Yes	A	C	1
229	Collapse	Yes	B	C	1
231	Fill/midden	Yes	C	C	1
232	Stone Floor	-	D	C	1
233	Surface	Yes	A	C	2
236	Collapse	Yes	B	C	2
239	Fill/midden	Yes	C	C	2
241	Fill/midden	Yes	C	C	2
242	Stone Floor	-	D	C	2
234	Surface	Yes	A	C	3
235	Collapse	Yes	B	C	3
237	Fill/midden	Yes	C	C	3
238	South Wall	-	F	C	3
240	Fill/midden	Yes	C	C	3

Unit 13 began as a small test unit (Cuad 0) placed inside the southwest corner of Structure 27, the large chapel/multi-purpose building at the very south end of the site. It was later expanded to 2m x 2m, with 4 separate quads. This unit was placed in Structure 27 to better understand the use of space inside this structure. Unit 13 had six separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A contained Loci 215, 216, 226, 233, and 234. These were all part of the surface soil, which was dark brown, loamy sand, semi-loose, with many roots. All of the sub-units had artifacts in the surface contexts, including ceramic fragments and lithics. We excavated until 24 cm. Context B included Loci 219, 221, 229, 235, and 236. This was wall collapse. The soil was dark brown, with clay, and inclusions of gravel, mud, and plaster. There were also many large rocks from the collapsed wall. Within the collapse, we found various artifacts, including ceramics, lithics, faunal remains, and burnt wood. We excavated until 41 cm.

Context C included Loci 231, 237, 239, 240, and 241. This was a type of trash fill event that was located on top of the living floor. This was likely the last period of occupation as the site was abandoned, but before the wall collapsed. This fill is in Cuad's 1, 2, and 3. The coil was very dark brown, with clay, and very compact. There was a variety of artifacts found here, like ceramics, lithics, animal bones, and metal. We excavated until 45 cm. Context D was directly below Context C and was the stone-lined floor. The floor was so well constructed that there was no soil that was able to be excavated from this level. This included Loci 225, 232, and 242, from Cuad's 0, 1, and 2. Context E was Locus 243, which was likely a second floor below the stone-lined floor. We removed some of the stones from Quad 0 to see what was below the stone floor, and found a level with dark brown soil, inclusions of clay, and plaster. There were also ceramics. We excavated this until 59 cm. Context F was the southern wall of Structure 27.

Unit 20, Sector C

Dimensions: Expanded Unit, 2m x 2m.

Depth: 39 cm.

Location: UTM (WGS 84) 388041.1 E, 8234744.53 N.

Description: Sector C, inside Structure 27 (the chapel). Near the "altar."

Declared Loci: 185, 188, 190, 193, 196, 198, 206, 210.

Table C.16: Unit 20 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
185	Surface	Yes	A	C	1
188	Surface	Yes	A	C	1
190	Surface	Yes	A	C	2
193	Surface	Yes	A	C	2
196	Surface	No	A	C	3
198	Surface	Yes	A	C	3
206	Surface	Yes	A	C	4
210	Collapse	No	B	C	1

Unit 20 began as a small test unit (Cuad 1) placed inside the east side of Structure 27, the large chapel/multi-purpose building at the very south end of the site. It was later expanded to 2m x 2m, with 4 separate quads. This unit was placed in Structure 27 to better understand the use of space inside this structure, and to determine if the east side held an altar. Unit 20 had two separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A includes most of the Loci excavated in Unit 20. That is: Loci 185, 188, 190, 193, and 206. These were all part of the surface soil, as there was a lot of erosion from the nearby hillside that led to the accumulation over the bedrock. The soil was brown, sandy, semi-compact, with roots and small rocks. We uncovered very few pieces of ceramic, and nothing more. We dug until 14 cm. In three of the cuads, we dug until bedrock. Context B included the collapse from the wall, with large rocks and clay. The soil was sandy and semi-loose. This was only excavated in Cuad 1 (the other cuads hit bedrock). We excavated until 39 cm, until we hit bedrock here, and found no cultural material.

Unit 21, Sector C

Dimensions: Expanded Unit, 1m x 3m.

Depth: 72 cm.

Location UTM (WGS 84) 388030.91 E, 8234746.16 N.

Description: Sector C, inside Structure 27 (the chapel).

Declared Loci: 120, 122, 125, 126, 128, 129, 132, 138, 140, 143, 148, 149, 152, 154, 156, 158, 159, 162, 164, 167, 171, 175, 180, 181, 183, and 212.

Table C.17: Unit 21 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
120	Surface	No	A	C	1
122	Surface	Yes	A	C	1
125	Fill	Yes	B	C	1
126	Surface	No	A	C	0
128	Surface	Yes	A	C	0
129	Fill	Yes	B	C	0
132	Fill	Yes	B	C	0
138	Surface	Yes	A	C	2
140	Fill	Yes	B	C	2
143	Fill	Yes	B	C	2
148	Burn Event	Yes	C	C	0
149	Burn Event	Yes	C	C	2
152	Dark floor	Yes	F	C	2
154	Burn Event	Yes	C	C	1
156	Roof collapse	Yes	D	C	1
158	Post hole?	No	E	C	1
159	Dark Floor	Yes	F	C	1
162	Floor #2	Yes	G	C	1
164	Floor #2	Yes	G	C	2
167	Floor #3	Yes	H	C	1
171	Dark Floor	Yes	F	C	0
175	Floor #2	Yes	G	C	0
180	Floor #3	Yes	H	C	0
181	Offering?		J	C	0
183	Floor #4	No	I	C	0
212	Floor #4	No	I	C	1

Unit 21 began as a small test unit (Cuad 1) placed inside Structure 27, the large chapel/multi-purpose building at the very south end of the site. It was later expanded to 1m x 3m, with 3 separate quads. This unit was placed in Structure 27 to better understand the use of space inside this structure. Unit 21 had nine separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Loci 121, 122, 126, 128, and 138. All were part of the surface soil, which was brown, sandy, semi-compact, with roots and small rocks. We found a few pieces of ceramics and dug until 18 cm. Context B included Loci 125, 129, 132, 140, and 143. These were part of a fill event, mixed with many artifacts. The soil color was brown, sandy, with clay, semi-compact, with small rocks. We excavated until 31 cm.

Context C was Loci 148, 149, and 154. This was a small burning level, possibly the end of occupation or a burning of the structure post-abandonment. The soil color was dark brownish black, sandy, and semi-compact. We uncovered ceramics and charcoal. We dug until 35 cm.

Context D/Locus 156 was likely roof collapse from the building. It included burnt wood. It was brown/black, clay-like, with charcoal. We did find some ceramics in this level. And excavated until 36 cm. Context E/Locus 158 was a possibly post hole – with loose, sandy soil, brown in color. There were no articles in this locus.

Context F was Loci 152, 159, and 171. These were part of a dark, compacted dirt floor. The soil color was dark brown, sandy with clay, and semi-compact. We found ceramics, metals, and a sheep/goat horn. We excavated until 41 cm. Context G was Loci 162, 164, and 175. These were another dirt floor, lighter in color, with more charcoal. We dug until 44 cm. Context H was Loci 167 and 180 and was a third floor – brown, sandy, and very compact with many flat ceramics. We dug until 71 cm. Context I was Loci 183 and 212 and were the fourth floor, dark brown and compact. There were no artifacts in this level. Context J was a possibly offering of ceramics at the beginning of the building stage. This was found near the principal doorway. The soil was dark brown, very sandy and loose, and included artifacts. We dug until 72 cm and did not dig further because of lack of time.

Unit 22, Sector C

Dimensions: Test unit 1m x 1m.

Location: UTM (WGS 84) 388030.91 E, 8234745.13 N.

Description: Sector C.

Was not excavated due to the high level of heavy metal concentration.

Unit 23, Sector C

Dimensions: Expanded Unit, 2m x 2m.

Depth: 41 cm.

Location UTM (WGS 84) 388029.76 E, 8234761.18 N.

Description: Sector C, Patio 5: midden.

Declared Loci: 034, 038, 161, 163, 165, 169, 174, 176, 177, 178, 186, 189, 192, 195.

Table C.18: Unit 23 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
034	Surface	Yes	A	C	0
038	Midden	Yes	B	C	0
161	Surface	Yes	A	C	1
163	Surface	Yes	A	C	1
165	Midden	Yes	B	C	1
169	Midden	Yes	B	C	1
174	Surface	Yes	A	C	2
176	Surface	Yes	A	C	2
177	Surface	Yes	A	C	2
178	Midden	Yes	B	C	2
186	Surface	Yes	A	C	3
189	Surface	Yes	A	C	3
192	Midden	Yes	B	C	3
195	Midden	Yes	B	C	3

Unit 23 began as a small test unit (Cuad 0) placed in Sector C's patio, in the midden area, on a steep hill. It was later expanded to 2m x 2m, with 4 separate quads. Unit 23 had two separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Loci 034, 161, 174, 176, 177, 186, and 189. These were all part of the surface soil, which was dark brown, semi-compact, clay-like, with many roots and small rocks. This context contained many artifacts. We stopped excavating at 18 cm, although this varied because the unit was on such a steep slope.

Context B included Loci 165, 169, 178, 192, and 195. These were the base of the midden, which was burned and included an ashy layer. The color of the soil was brownish grey, very sandy, and semi-compact. There were many inclusions of charcoal, was well as many different types of artifacts, including many animal bones and ceramic fragments. We stopped excavating when we reached hard bedrock. This was roughly 41 cm.

Unit 24, Sector C

Dimensions: Expanded Unit, 1m x 3m.

Depth: 107 cm.

Location UTM (WGS 84) 388034.05 E, 8234755.83 N.

Description: Sector C, Building 25.

Declared Loci: 028, 030, 032, 035, 036, 040, 041, 043, 182, 184, 187, 191, 194, 197, 209, 218, 222, 224, and 228.

Table C.19: Unit 24 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
028	Surface	-	A	C	0
030	Surface	Yes	A	C	0
032	Surface	Yes	A	C	0
035	Fill	Yes	B	C	0
036	Fill	Yes	B	C	0
040	Fill	Yes	B	C	0
041	Living Floor	Yes	C	C	0
043	Hearth	Yes	D	C	0
182	Surface	Yes	A	C	1
184	Surface	Yes	A	C	1
187	Fill	Yes	B	C	1
191	Fill	Yes	B	C	1
194	Surface	Yes	A	C	2
197	Surface	Yes	A	C	2
200	Fill	Yes	B	C	2
203	Fill	Yes	B	C	2
209	Living Floor	Yes	C	C	1
218	Living Floor	Yes	C	C	1
214	Living Floor	Yes	C	C	0
222	Below Floor	Yes	E	C	1
224	Rock cut (not excavated)	-	F	C	1
228	Sterile	No	G	C	1

Unit 24 began as a small test unit (Cuad 0) placed in Sector C's Structure 25, which was possibly a caretaker building for the nearby chapel. It was later expanded to 1m x 3m, with 3 separate quads. Unit 24 had seven separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A, including Loci 028, 030, 032, 182, 194, and 197, were part of the surface soil. The soil color was very dark brown, loamy, loose, with many roots. We found various ceramics and animal bones in this level, as well as rock collapse from the walls. We dug until 34 cm. Context B, including Loci 035, 036, 040, 187, 191, 200, and 203, were a large fill event under the collapse and surface level. The soil was very dark brown, semi-loose, with many inclusions of charcoal and clay. There were many artifacts in the fill, including ceramics, animal bones, and metals. We dug until 57 cm, when we encountered a floor.

Context C included Loci 041, 209, 218, and 214. This was a compacted, dirt living floor. It was reddish brown, semi-compact, with inclusions, including many artifacts and charcoal. We excavated until 77 cm. Context D/Locus 043 was a hearth in the SW corner of the building. The soil was very ashy, dark grey/white in color, very fine and loose, with many charcoal and ashy inclusions. Within the hearth, we found ceramics. We excavated until 85 cm. Context E/Locus 222 was a level of fill below the floor, potentially to prepare the floor. The soil was dark reddish brown, loamy, semi-compact, with gravel, stones, and clay inclusions. We found various artifacts in this level as well and dug until 91 cm. Context G/Locus 228 was a sterile level, dark grey, sandy, semi-compact, with gravel. There were no artifacts and we excavated until 107 cm.

Unit 25, Sector C

Dimensions: Expanded Unit, 1m x 2m.

Depth: 30 cm.

Location UTM (WGS 84) 388039.43 E, 8234760.06 N.

Description: Sector C, Patio 5: midden.

Declared Loci: 044, 047, 050, 211, 213.

Table C.20: Unit 25 Locus Descriptions.

Locus	Description	Material?	Context	Sector	Cuad
044	Surface	Yes	A	C	0
047	Midden	Yes	B	C	0
050	Midden	Yes	B	C	0
211	Surface	Yes	A	C	1
213	Midden	Yes	B	C	1

Unit 25 began as a small test unit (Cuad 0) placed in Sector C's patio, in the midden area, on a steep hill. It was later expanded to 1m x 2m, with 2 separate quads. Unit 25 had two separate contexts, among various nature strata and arbitrary levels (identified as loci).

Context A included Loci 044 and 211. These were all part of the surface soil, which was dark brown, semi-compact, clay-like, with many roots and small rocks. This context contained many artifacts. We stopped excavating at 10 cm, although this varied because the unit was on such a steep slope.

Context B included Loci 047, 050, and 213. These were the base of the midden, which was burned and included an ashy layer. The color of the soil was brownish grey, very sandy, and semi-compact. There were many inclusions of charcoal, was well as many different types of artifacts, including many animal bones and ceramic fragments. We stopped excavating when we reached hard bedrock. This was roughly 30 cm.

Appendix D Diagnostic Artifact Drawings

In Appendix D, I include the following:

- Diagnostic drawing of select lithic tools.
- Diagnostic drawings of select ceramic rims and shapes.
- All drawings in this appendix were done by Javier Chalcha Saraza

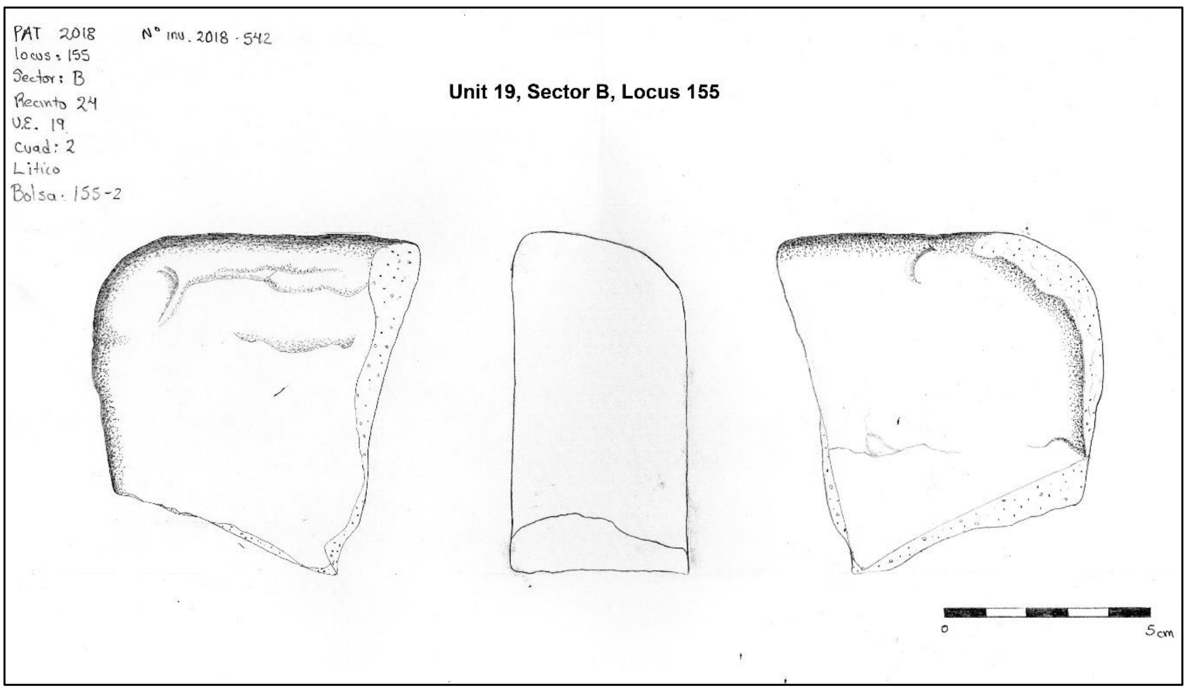

Figure D.1: Grinding stone from Unit 19, Sector B, Locus 155, the floor level.

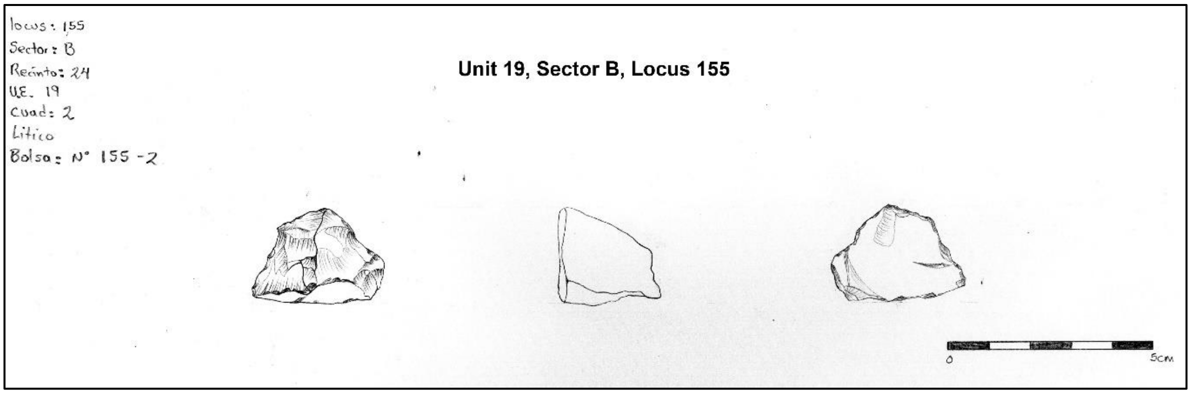

Figure D.2: Lithic core from Unit 19, Sector B, Locus 155, the floor level.

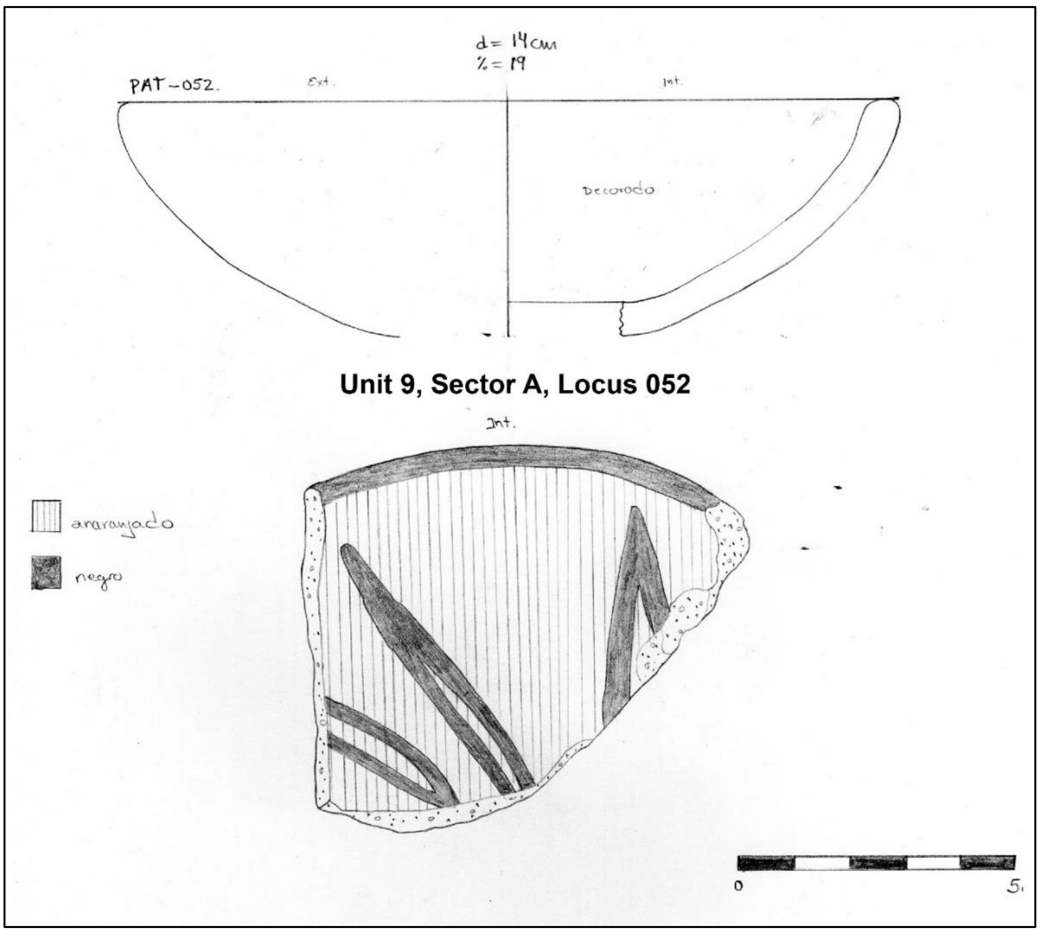

Figure D.3: Local ceramic serving plate from Unit 9, Sector A, Locus 052, the surface level.

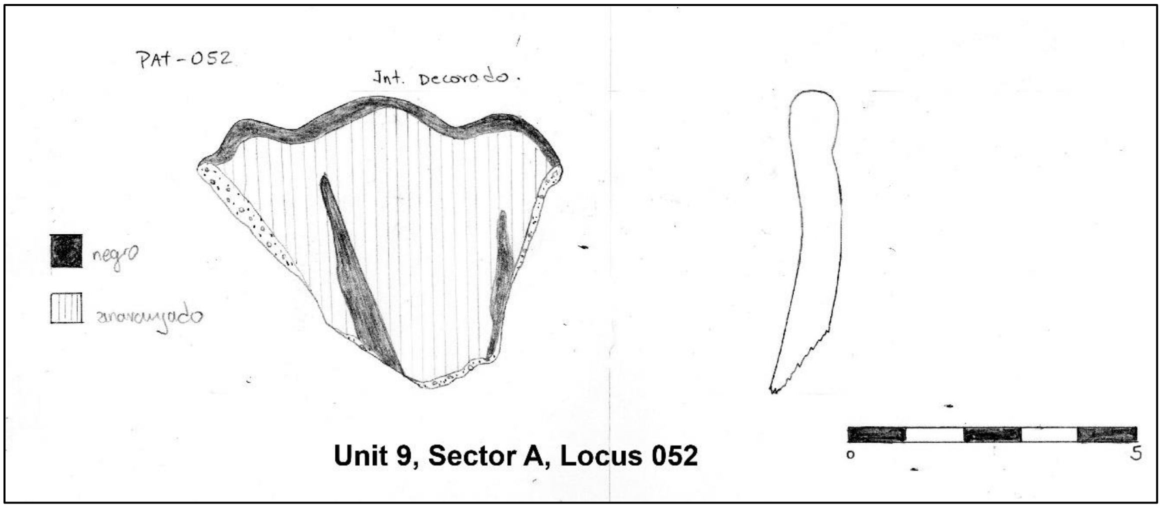

Figure D.4: Local ceramic serving plate from Unit 9, Sector A, Locus 052, the surface level.

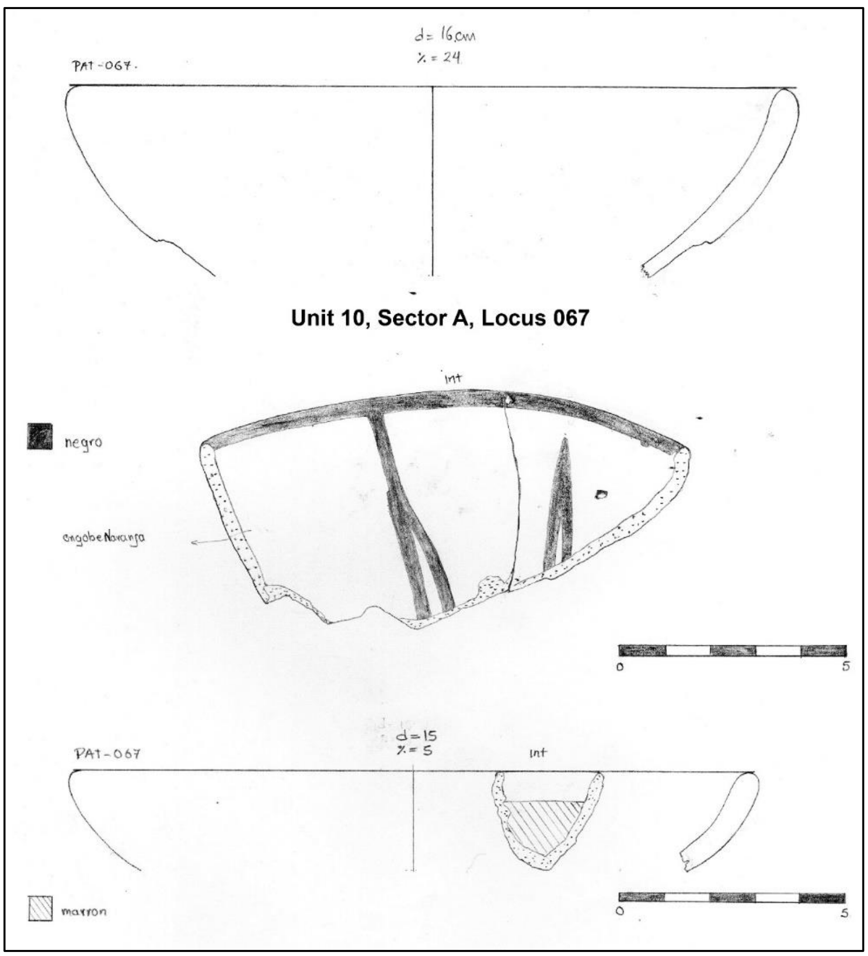

Figure D.5: Local ceramic serving plate from Unit 10, Sector A, Locus 067, the wall collapse level.

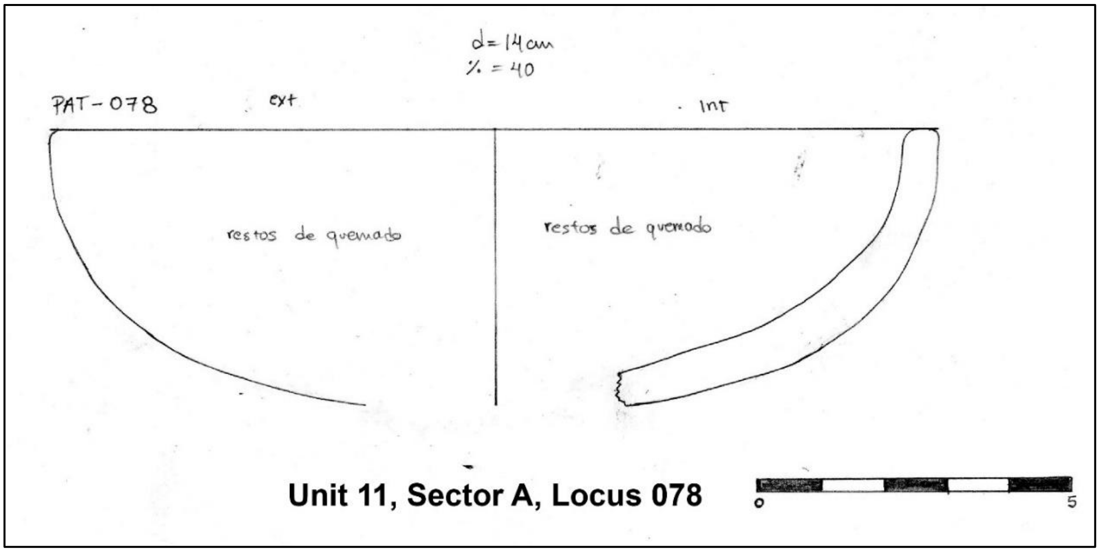

Figure D.6: Shallow bowl from Unit 11, Sector A, Locus 078, on top of the stone floor.

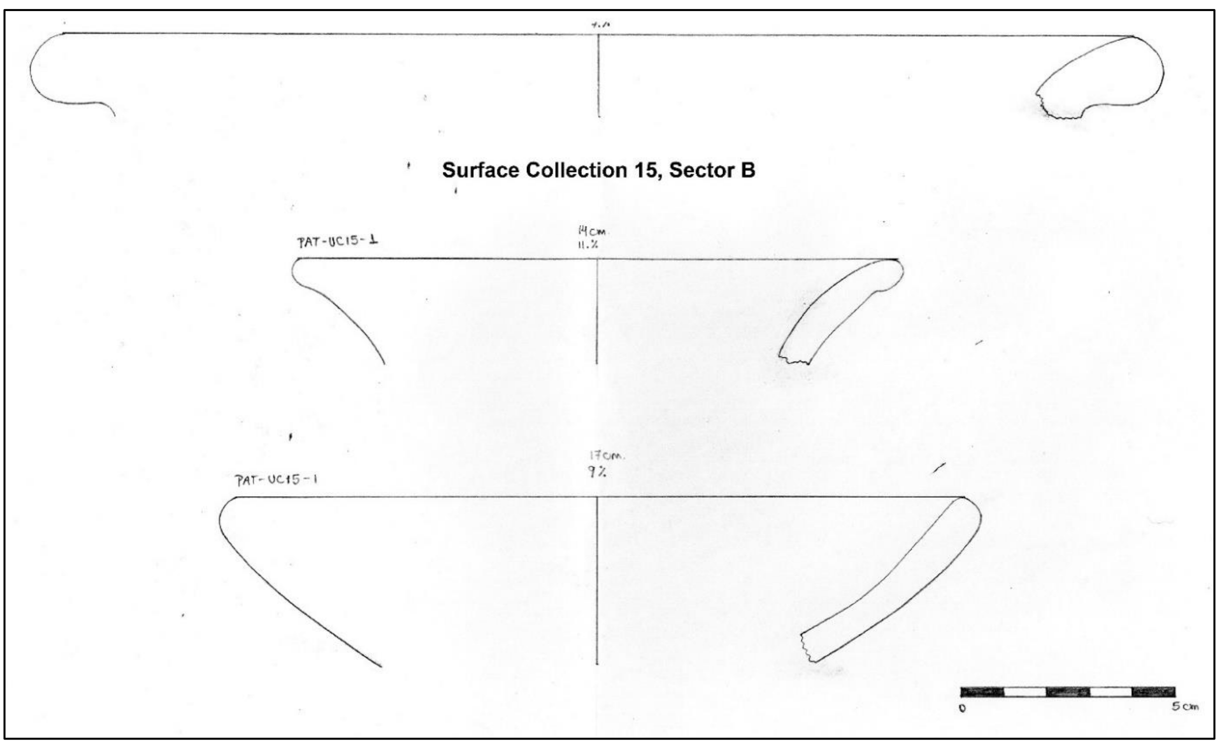

Figure D.7: Ceramic rims of various vessels found in surface collection unit 15, Sector B.

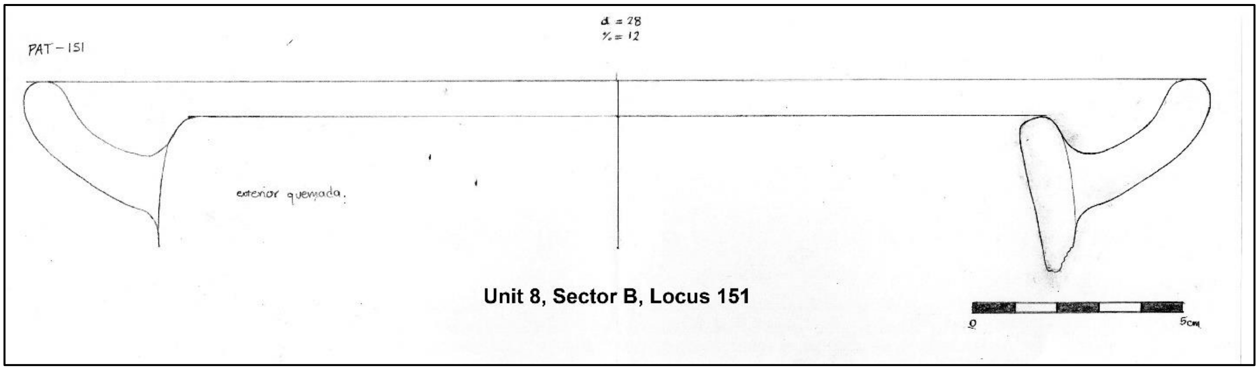

Figure D.8: Mercury pot from Unit 8, Sector B, Locus 151, within the mercury oven.

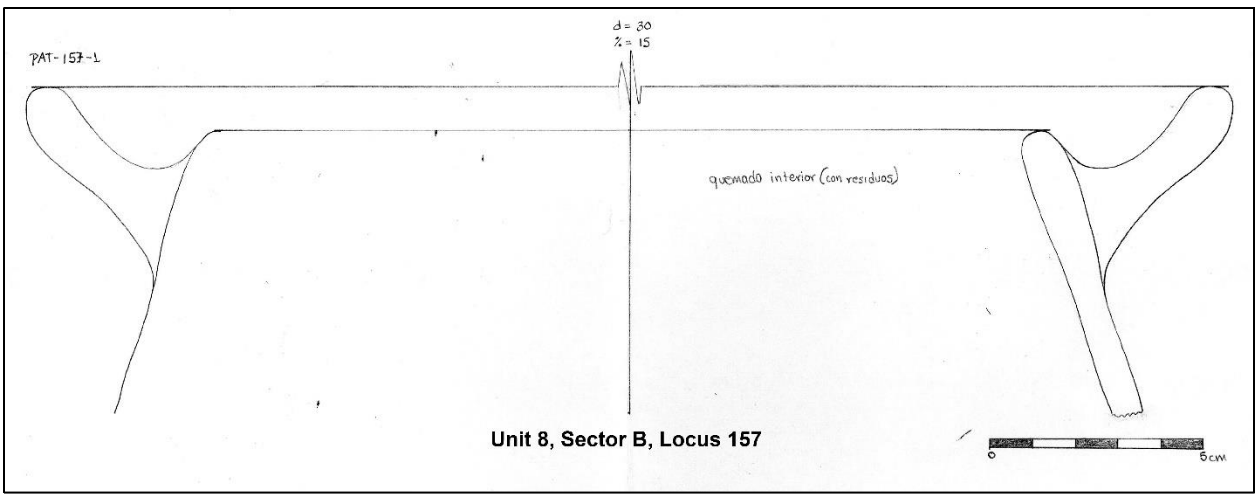

Figure D.9: Mercury pot from Unit 8, Sector B, Locus 157, within the ash layer of the mercury oven.

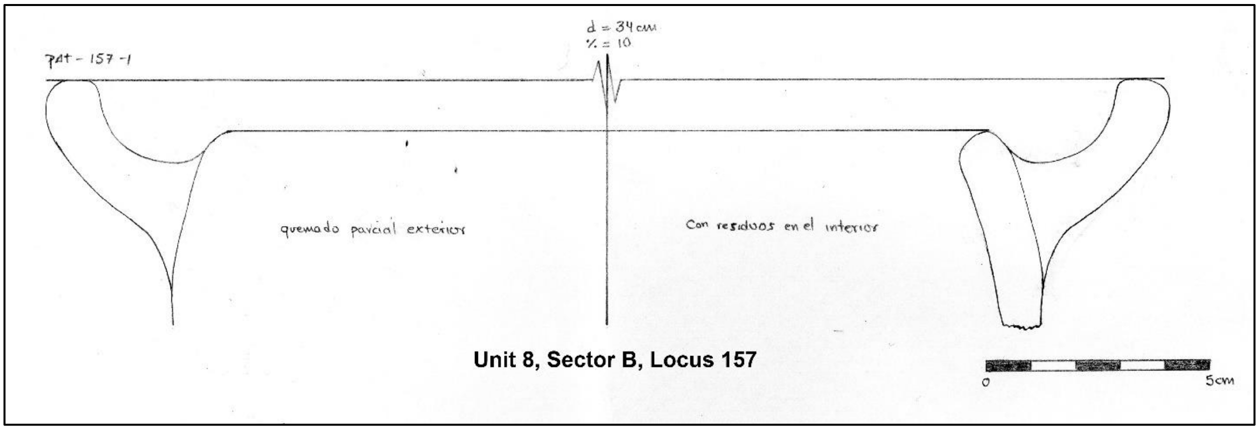

Figure D.10: Mercury pot from Unit 8, Sector B, Locus 157, within the ash layer of the mercury oven.

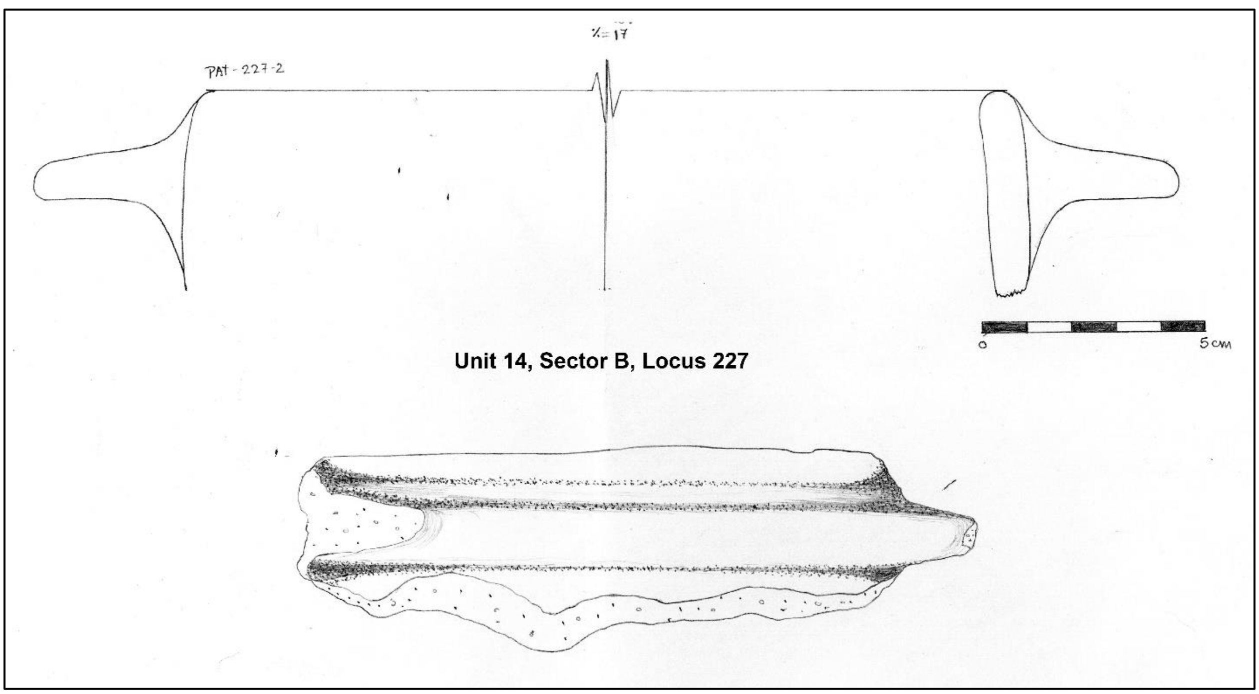

Figure D.11: Mercury pot from Unit 14, Sector B, Locus 227, within a burning layer.

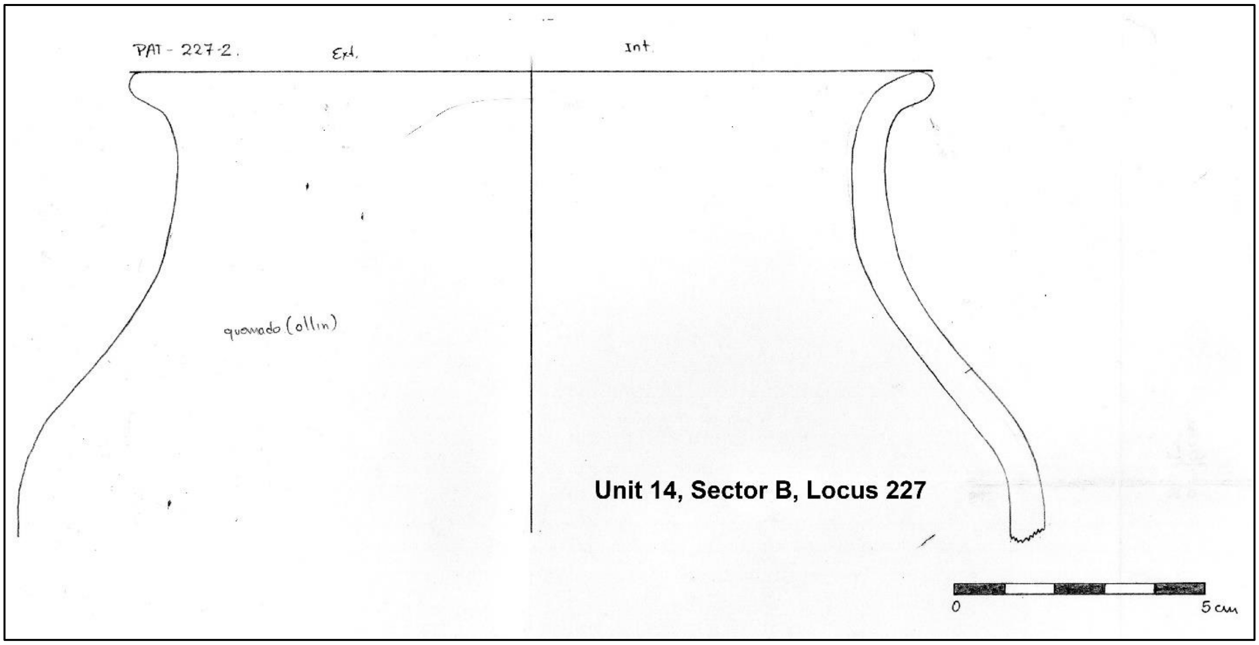

Figure D.12: Rim of a vessel from Unit 14, Sector B, Locus 227, within a burning layer.

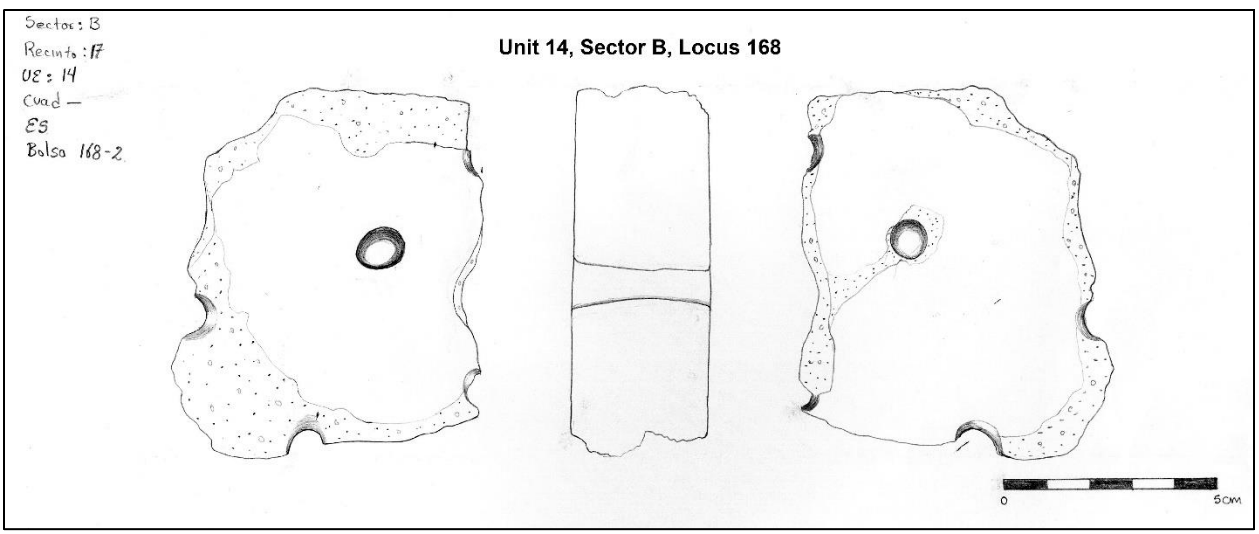

Figure D.13: Mercury pot lid, with perforated holes from Unit 14, Sector B, Locus 168, the surface.

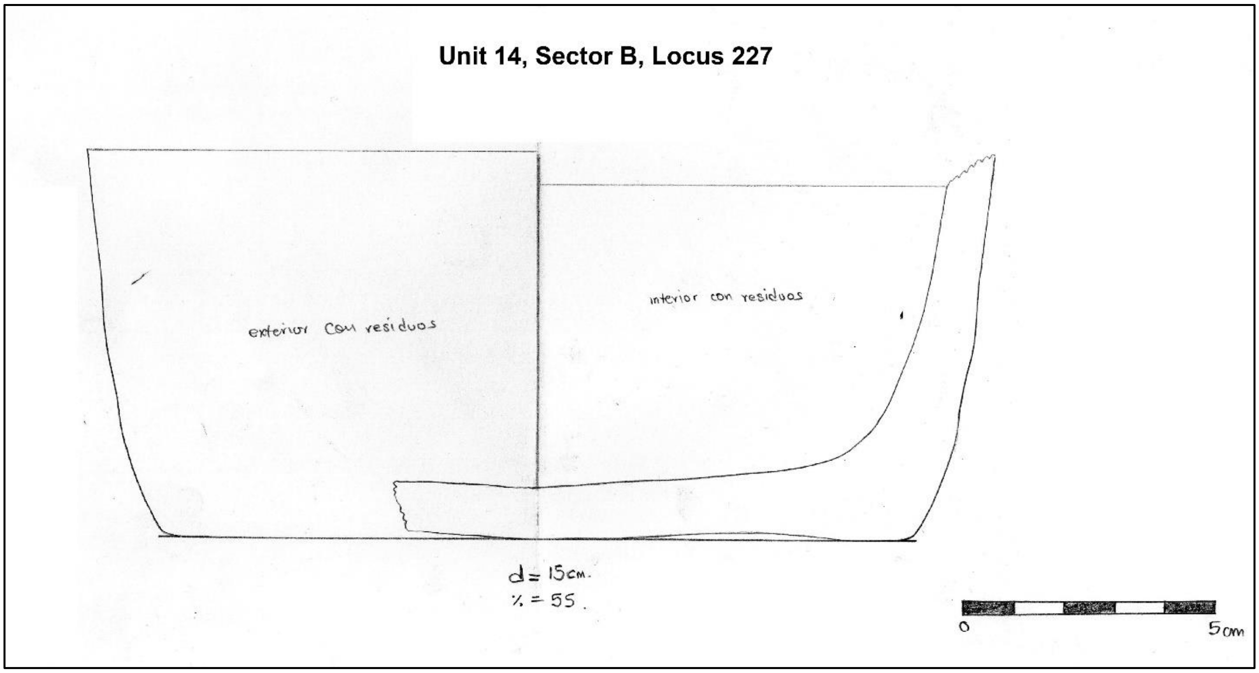

Figure D.14: Vessel and base from Unit 14, Sector B, Locus 227, the burning layer.

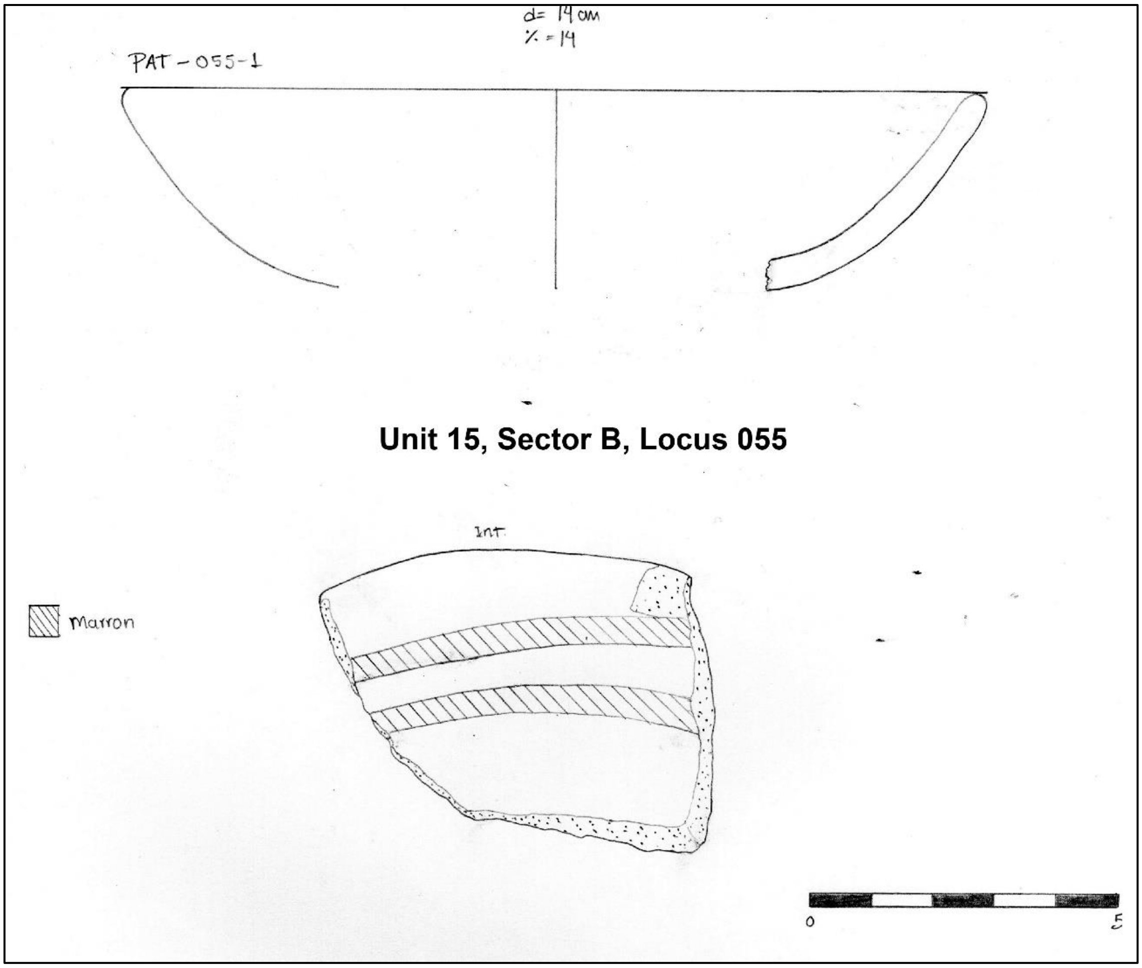

Figure D.15: Shallow bowl with interior design from Unit 15, Sector B, Locus 055, within fill above the floor.

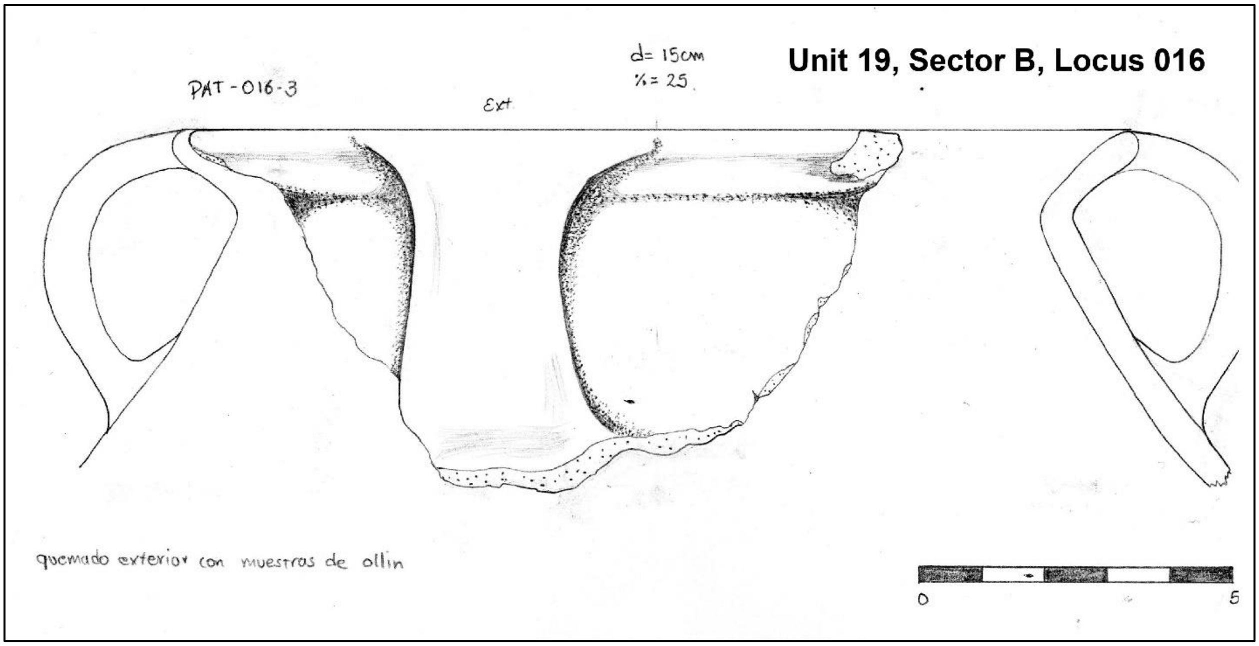

Figure D.16: Vessel rim and handle from Unit 19, Sector B, Locus 016, from on top of the floor.

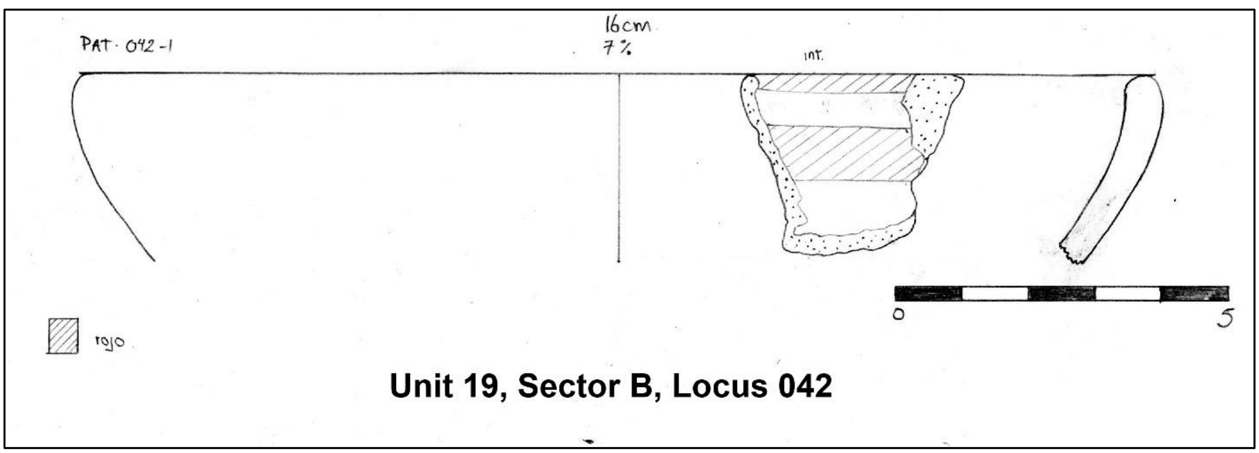

Figure D.17: Shallow bowl with interior design from Unit 19, Sector B, Locus 042, the house midden.

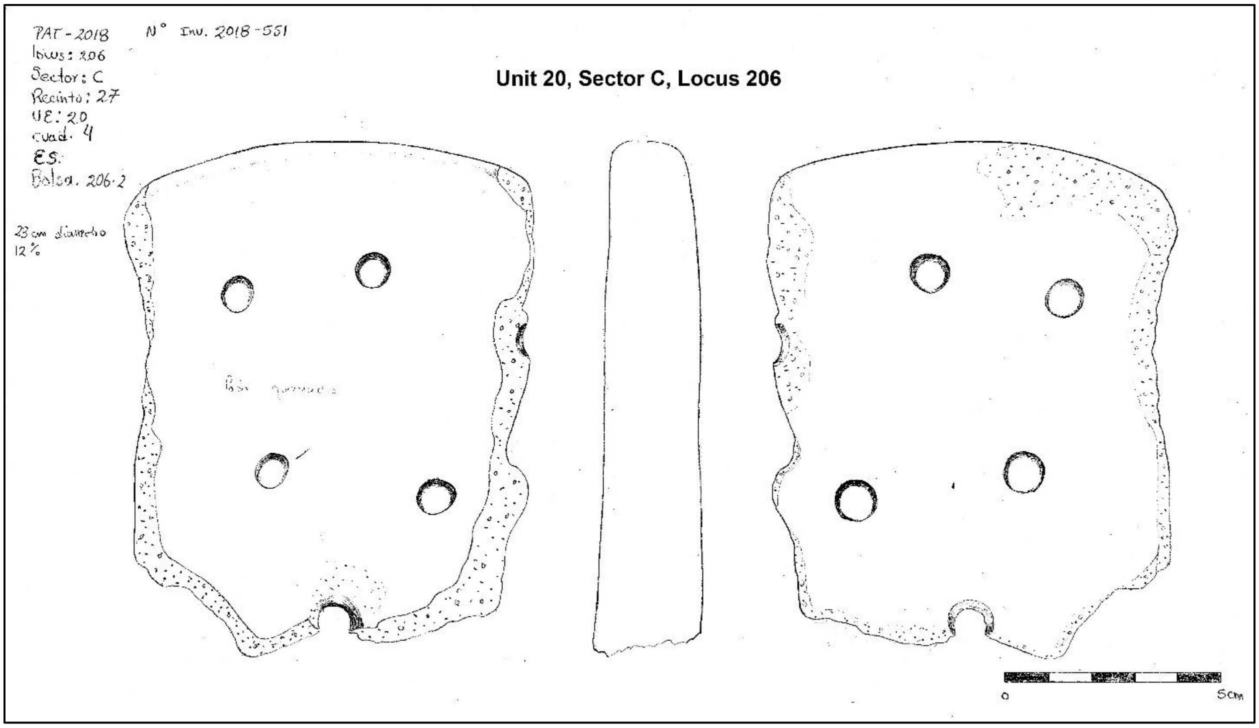

Figure D.18: Mercury pot lid, with perforated holes from Unit 20, Sector C, Locus 206, the surface.

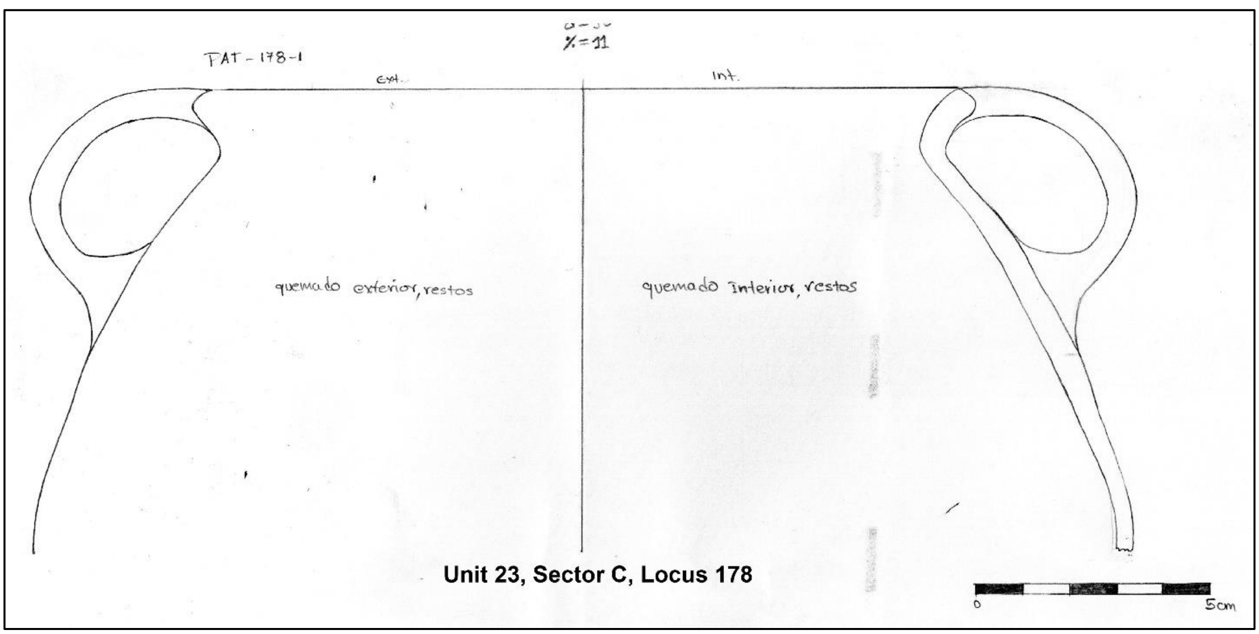

Figure D.19: Vessel rim with handle, from Unit 23, Sector C, Locus 178, the midden.

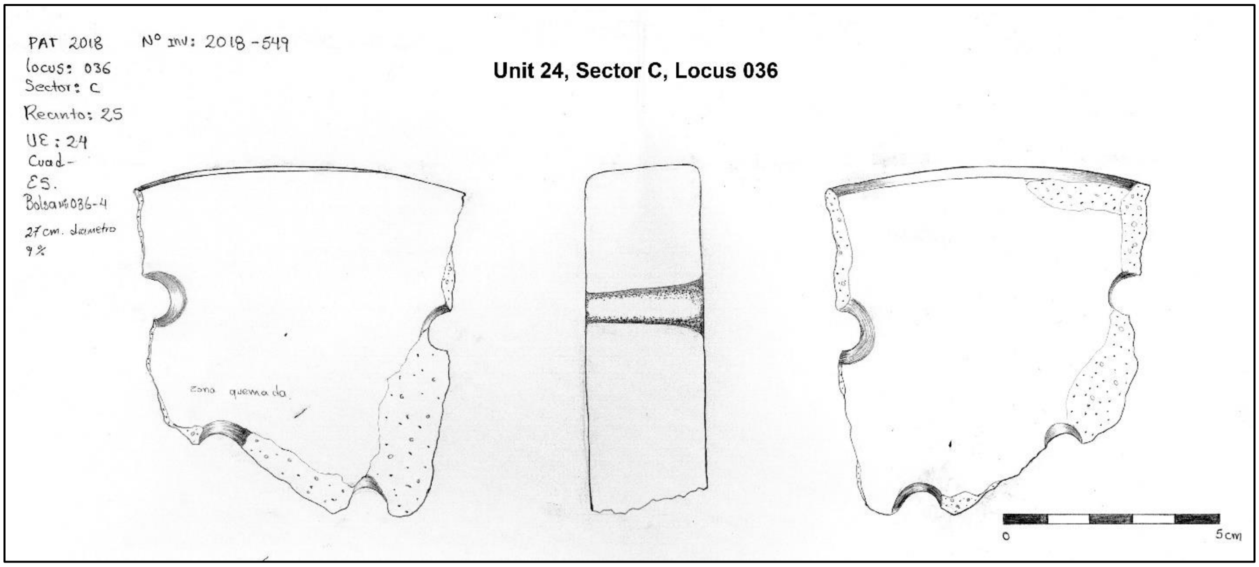

Figure D.20: Mercury pot lid, with perforated holes from Unit 24, Sector C, Locus 036, the fill.

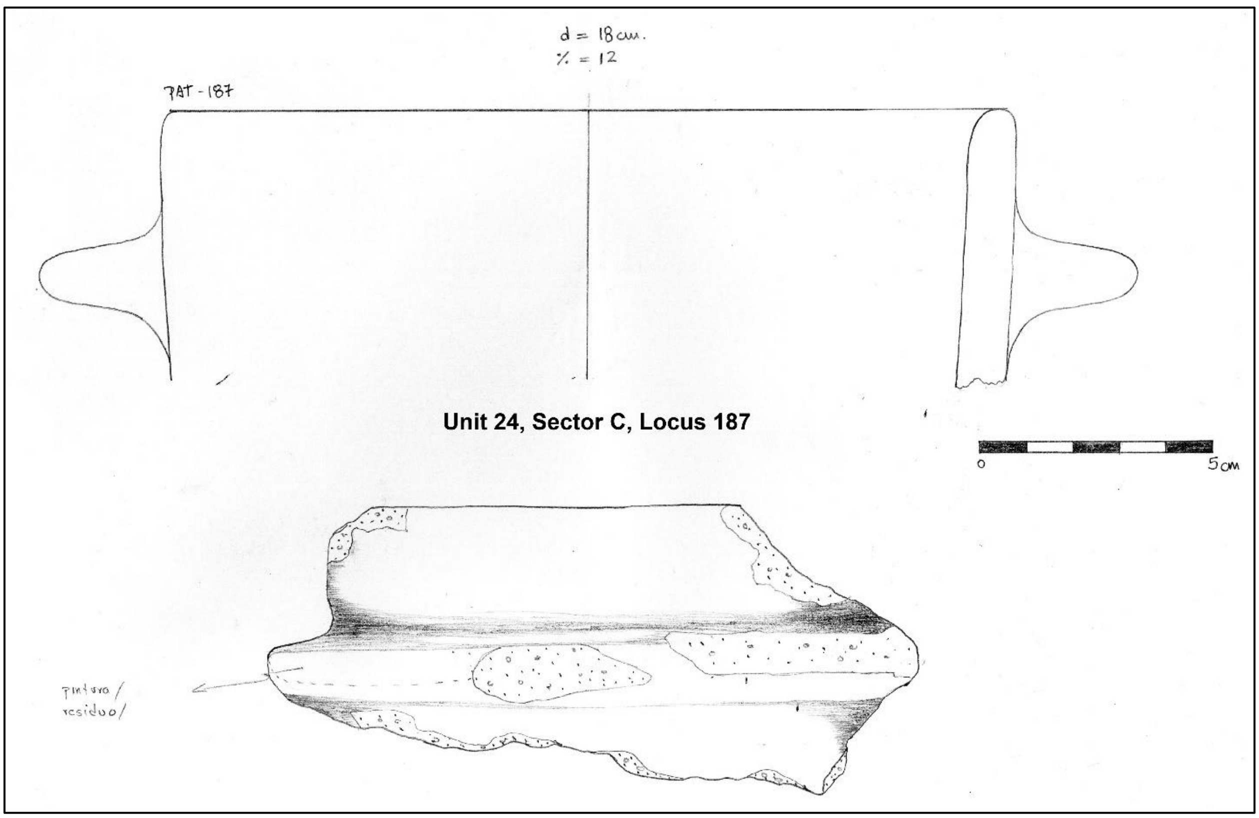

Figure D.21: Mercury pot from Unit 24, Sector C, Locus 187, the fill.

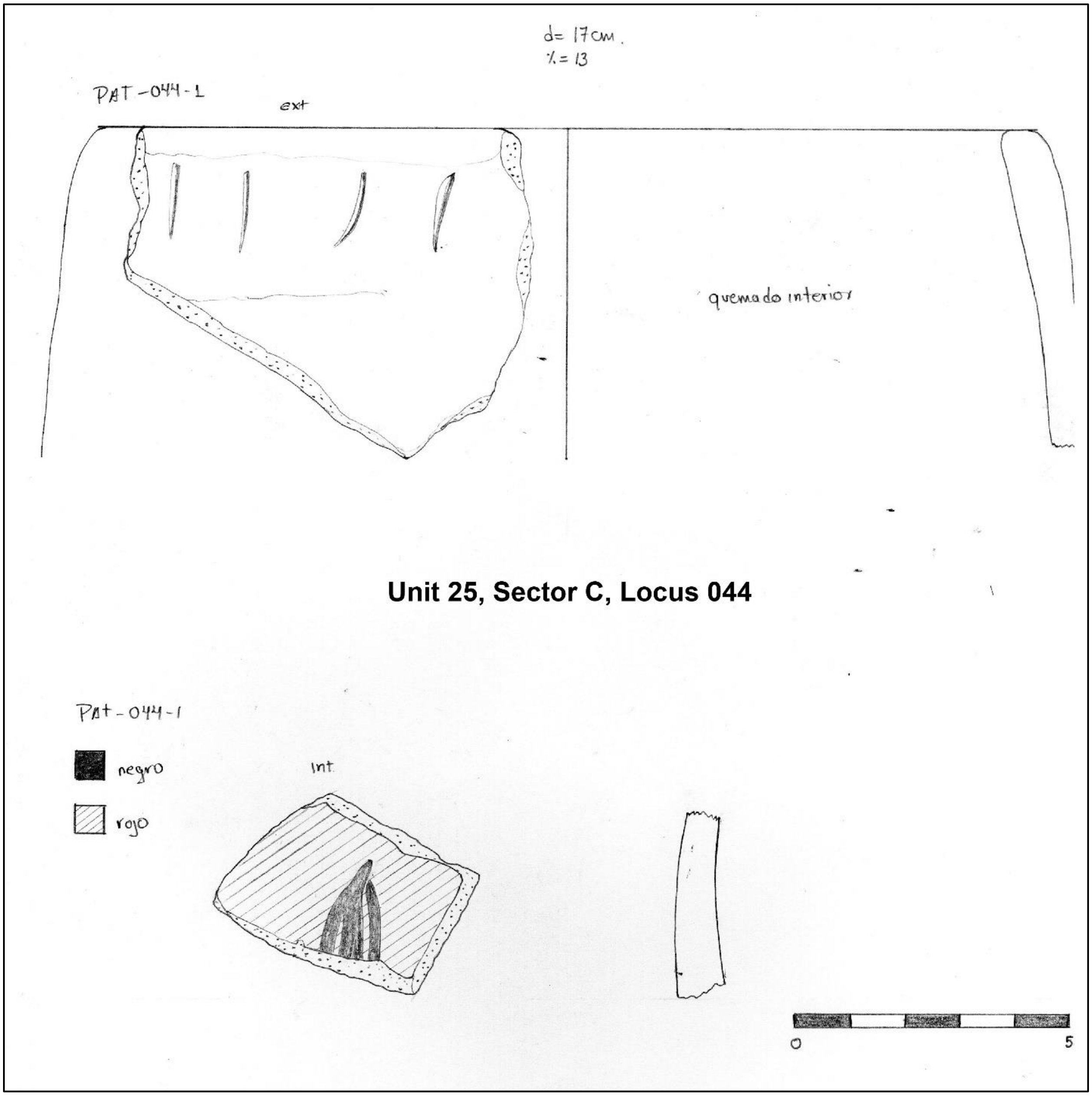

Figure D.22: Mercury pot from Unit 24, Sector C, Locus 187, the fill.

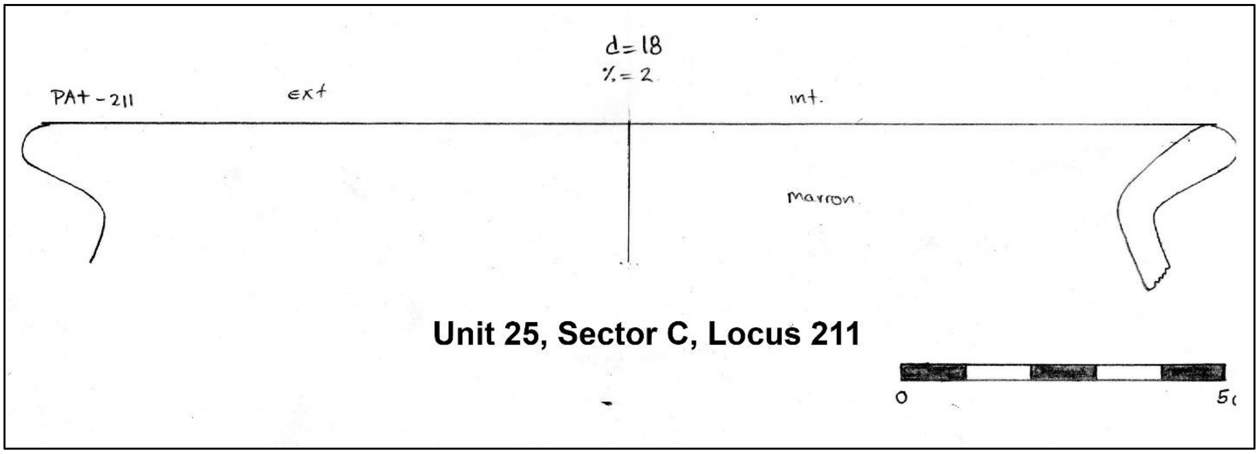

Figure D.23: Mercury pot from Unit 24, Sector C, Locus 187, the fill.

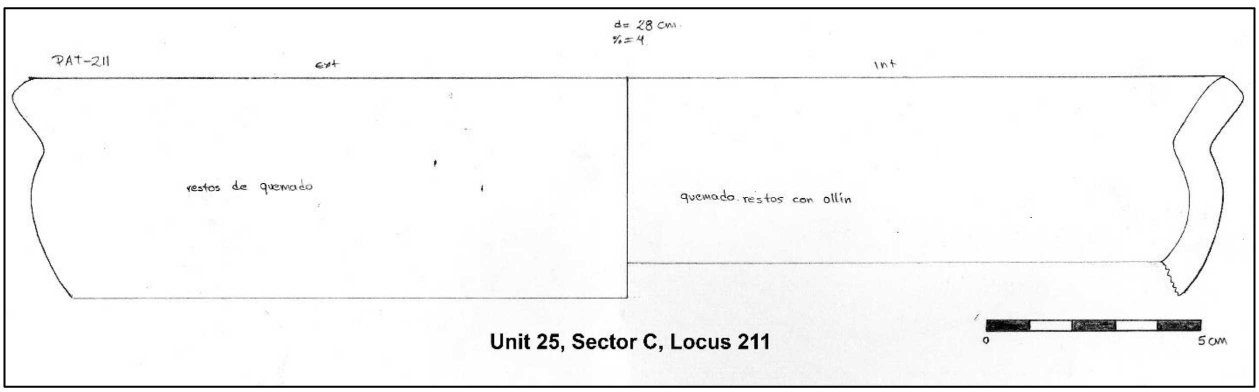

Figure D.24: Rim from Unit 25, Sector C, Locus 211, the midden.

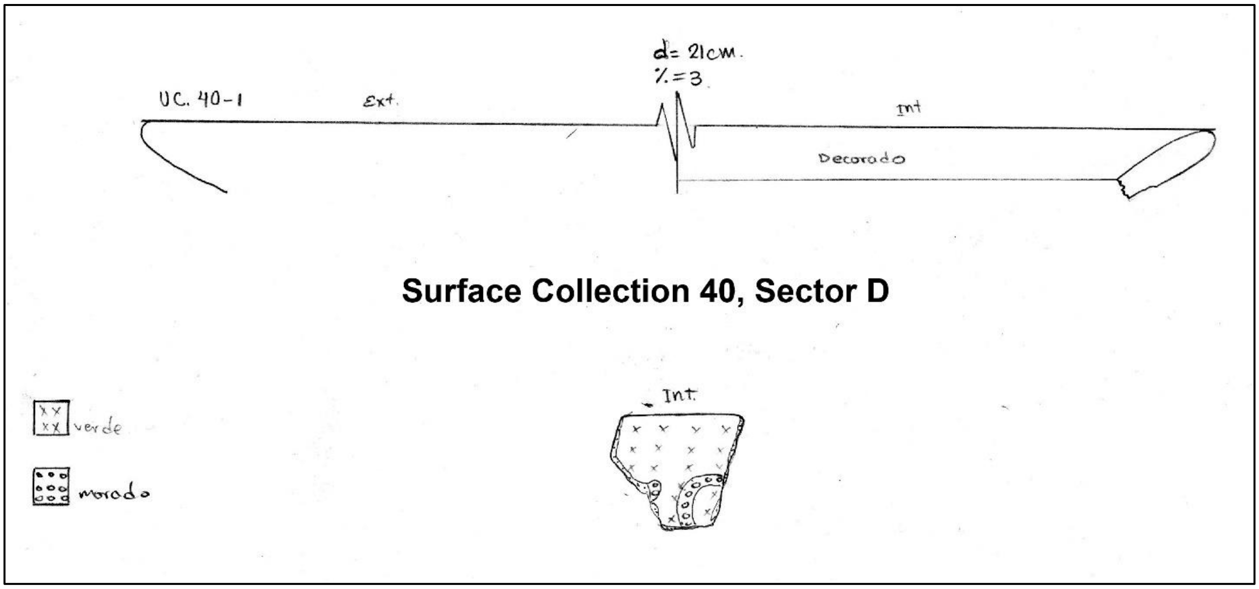

Figure D.25: Majolica (tin-glazed) ceramic plate from surface collection unit 40, Sector D.

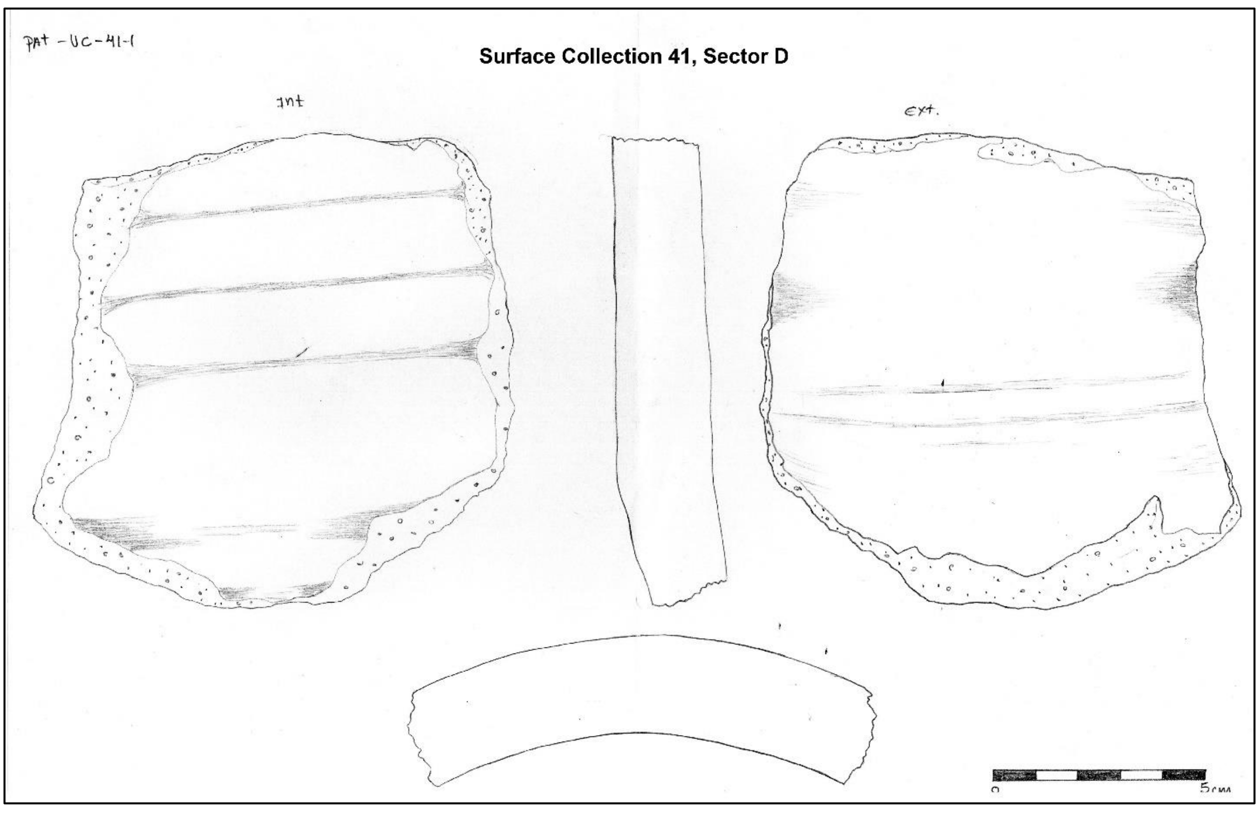

Figure D.26: Botija (olive jar) fragment from surface collection unit 41, Sector D.

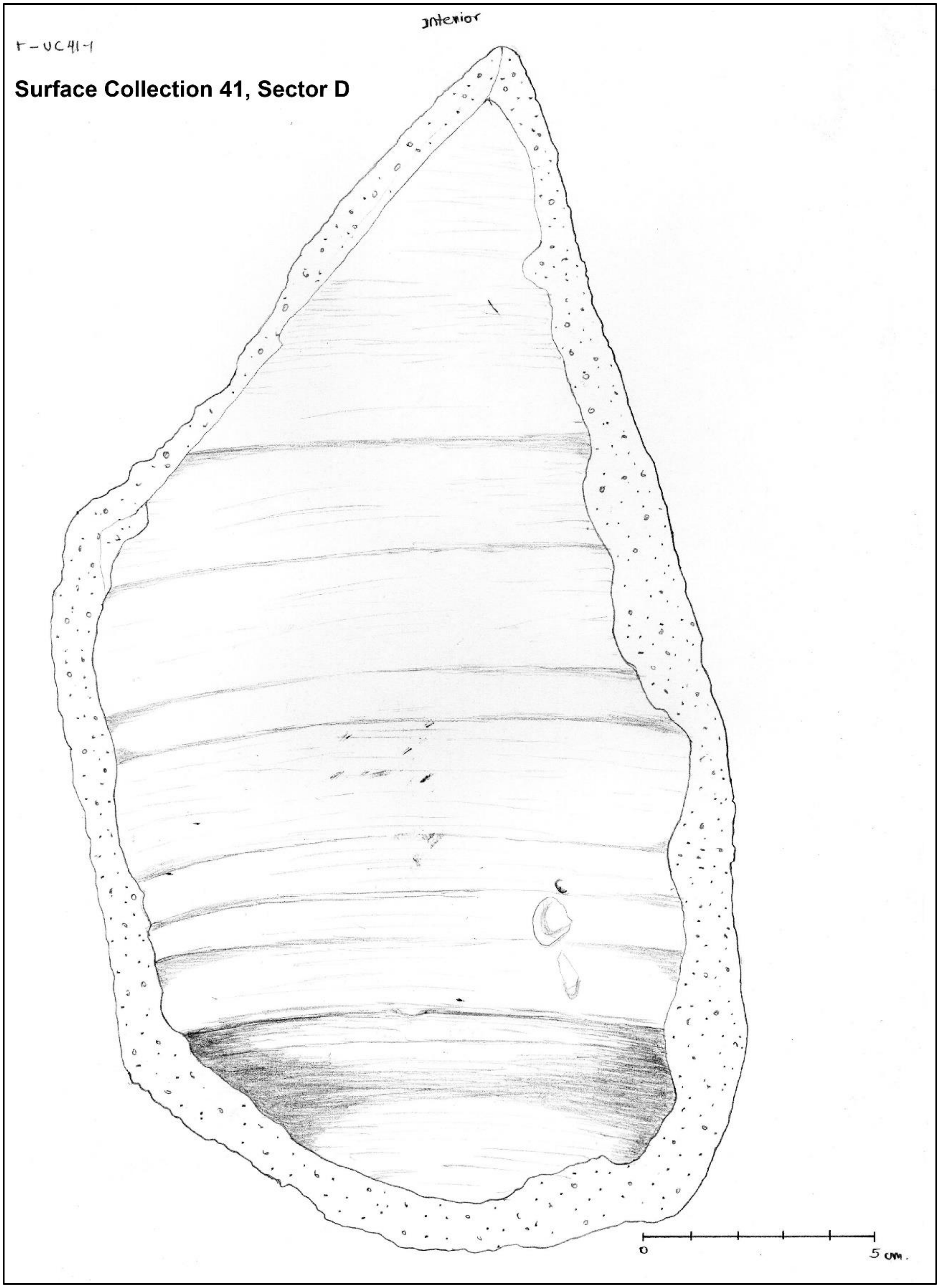

Figure D.27: The interior of a botija (olive jar) fragment from surface collection unit 41, Sector D.

Appendix E Artifact Analysis Statistical Results

In Appendix E, I include the following:

- Systat output of chi-square results for faunal analysis
- Systat output of chi-square results for ceramic analysis
- Systat output of chi-square results for occupation (using ceramics)

Table E.1: Faunal Analysis Chi-Square Test of Association for Sectors and Taxa.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	58.901	22	0.000
Phi	0.458	-	-
Cramer’s V	0.324	-	-

Table E.2: Ceramic Analysis Chi-Square Test of Association for Sectors and Styles.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	59.826	4	0.000
Phi	0.313	-	-
Cramer’s V	0.222	-	-

Table E.3: Ceramic Analysis Chi-Square Test of Association for Sectors and Function.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	207.2	10	0.000
Phi	0.426	-	-
Cramer’s V	0.301	-	-

Table E.4: Ceramic Analysis Chi-Square Test of Association for Sectors and Ware.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	317.713	14	0.000
Phi	0.370	-	-
Cramer's V	0.262	-	-

Table E.5: Ceramic Analysis Chi-Square Test of Association for Sectors and Form.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	118.477	14	0.000
Phi	0.421	-	-
Cramer's V	0.298	-	-

Table E.6: Ceramic Analysis Chi-Square Test of Association for Type and Style.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	11.73	4	0.019
Phi	0.130	-	-
Cramer's V	0.092	-	-

Table E.7: Ceramic Analysis Chi-Square Test of Association for Period and Function.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	26.245	3	0.00
Cramer's V	0.142	-	-

Table E.8: Ceramic Analysis Chi-Square Test of Association for Phase and Style in Unit 24.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	28.25	4	0.000
Phi	0.514	-	-
Cramer's V	0.363	-	-

Table E.9: Ceramic Analysis Chi-Square Test of Association for Phase and Ware in Unit 24.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	41.952	10	0.000
Phi	-	-	-
Cramer's V	0.311	-	-

Table E.10: Ceramic Analysis Chi-Square Test of Association for Phase and Function in Unit 24.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	17.244	6	0.008
Phi	-	-	-
Cramer's V	0.326	-	-

Table E.11: Ceramic Analysis Chi-Square Test of Association for Phase and Function in Units 21 and 13.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	14.182	8	0.077
Phi	-	-	-
Cramer's V	0.438	-	-

Table E.12: Ceramic Analysis Chi-Square Test of Association for Phase and Ware in Units 21 and 13.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	32.242	24	0.121
Phi	-	-	-
Cramer's V	0.142	-	-

Table E.13: Ceramic Analysis Chi-Square Test of Association for Phase and Function in Units 21 and 13.

Test	Value	Degrees of Freedom	p-Value
Pearson Chi-Square	20.722	12	0.055
Phi	-	-	-
Cramer's V	0.156	-	-

Appendix F Radiocarbon Dating Results

In Appendix F, I include the following:

- Figures with the calibrated date ranges for radiocarbon samples BK14, BK 13, BK8, BK2, and BK01.

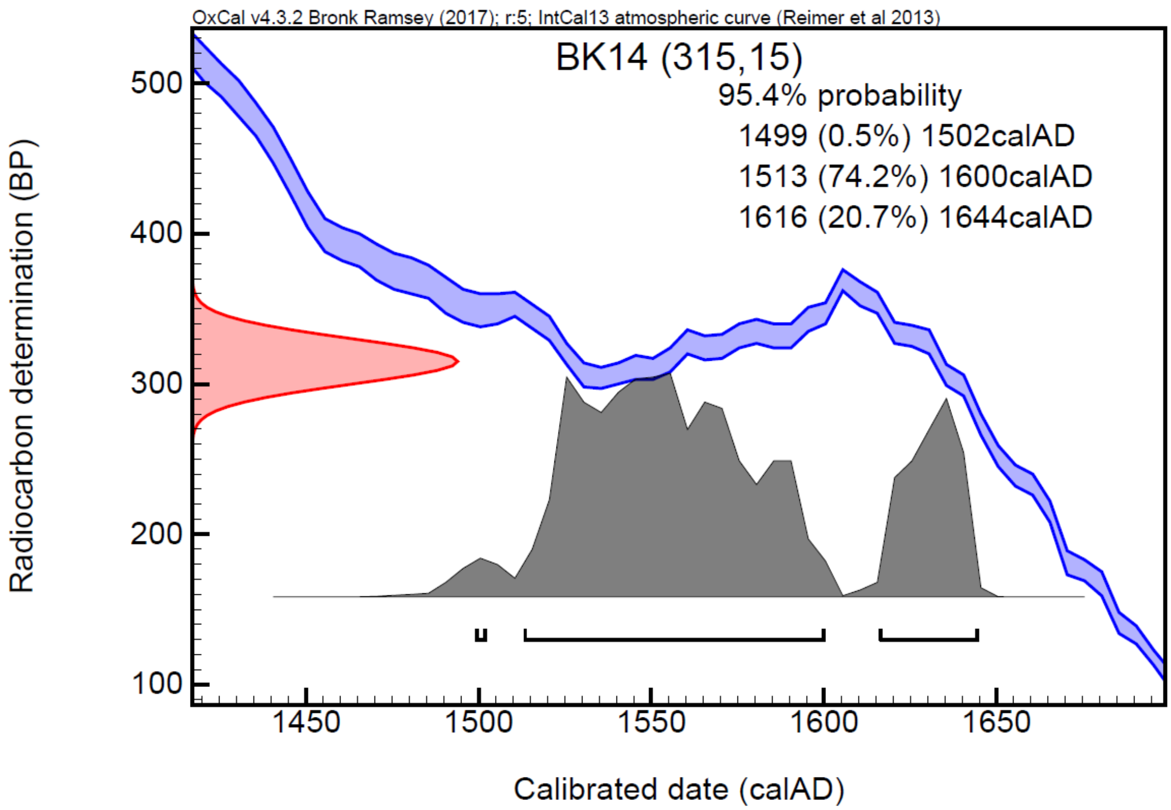

Figure F.1: Calibrated date ranges for radiocarbon sample BK14.

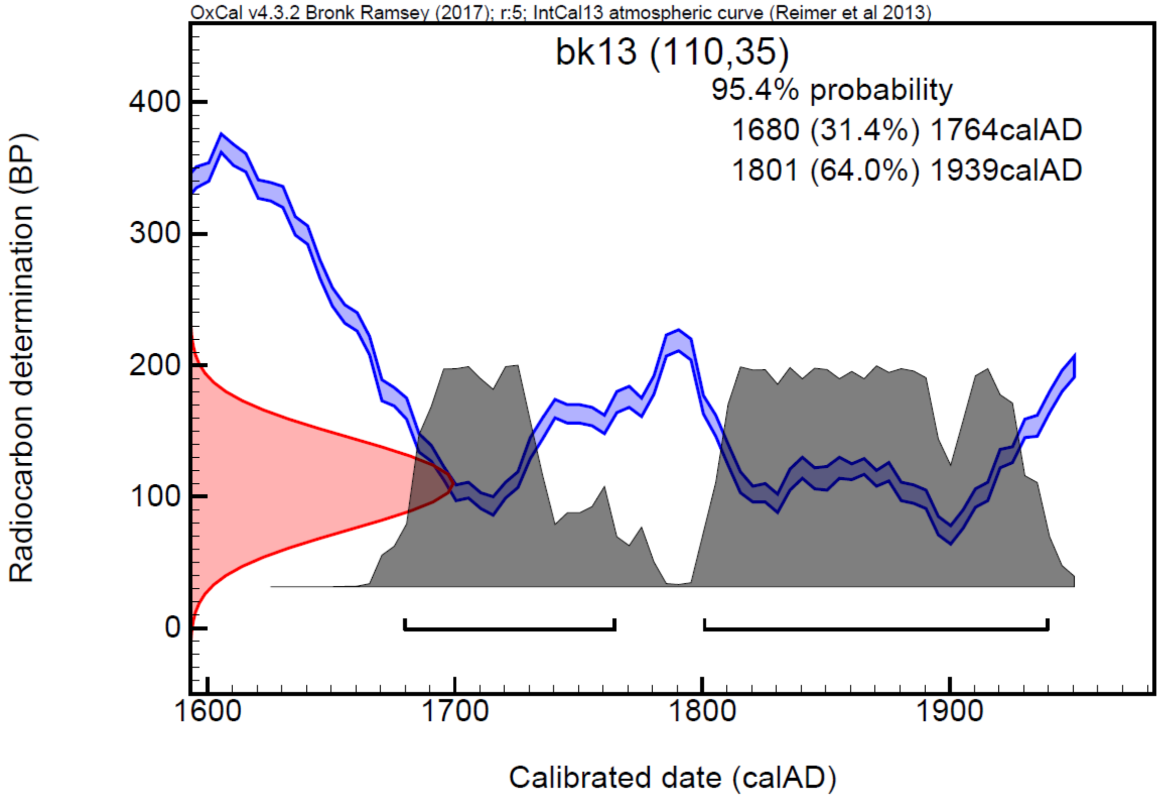

Figure F.2: Calibrated date ranges for radiocarbon sample BK13.

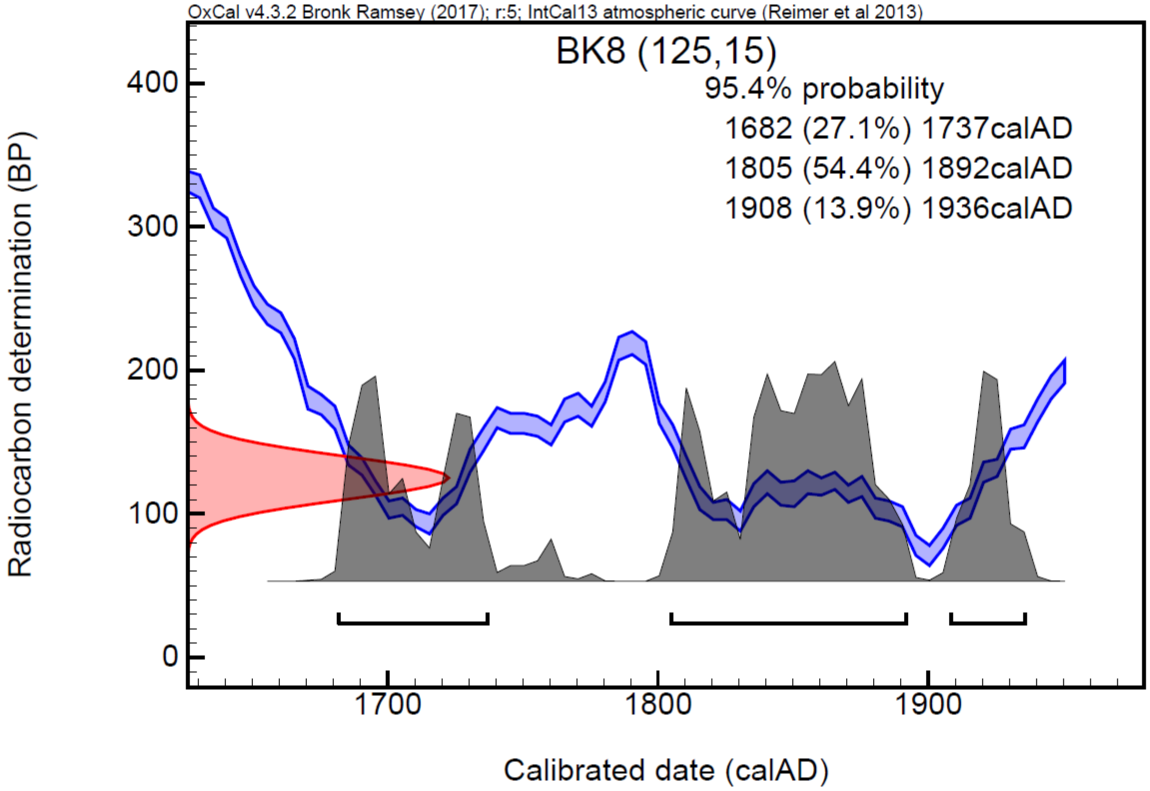

Figure F.3: Calibrated date ranges for radiocarbon sample BK8.

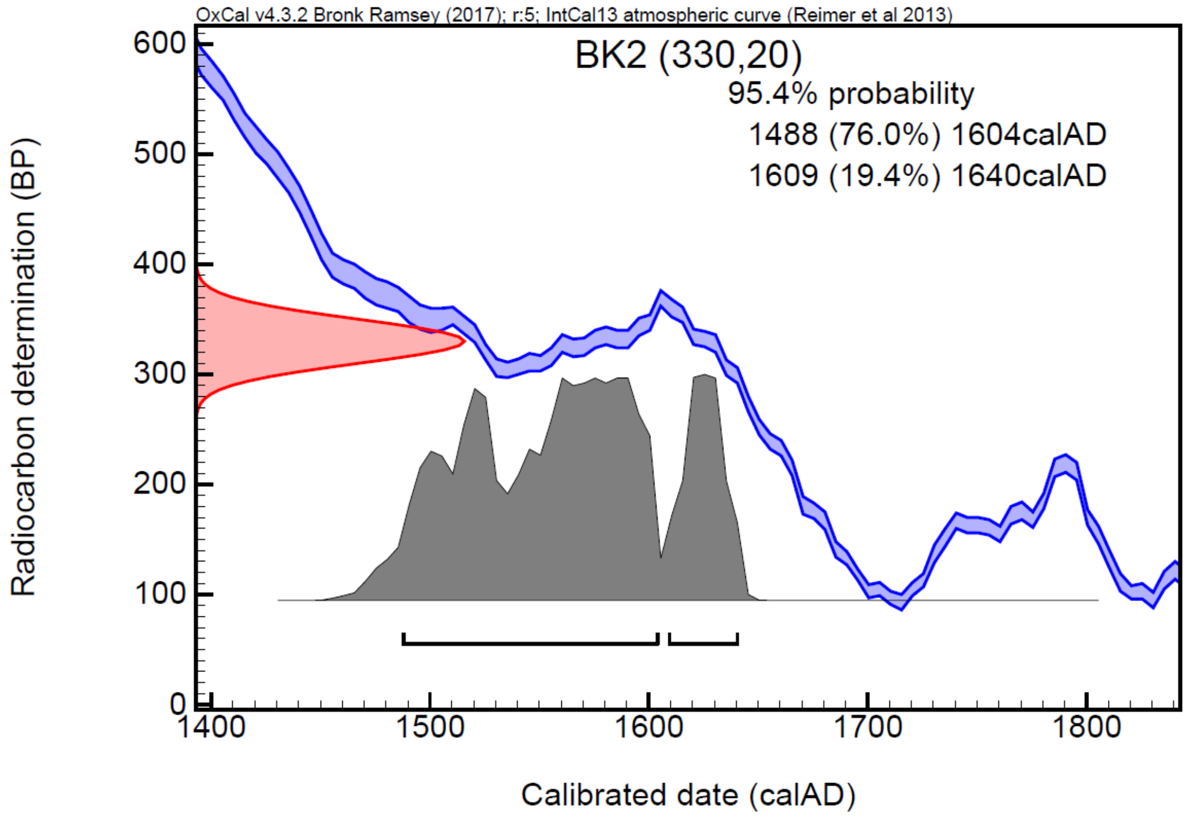

Figure F.4: Calibrated date ranges for radiocarbon sample BK2.

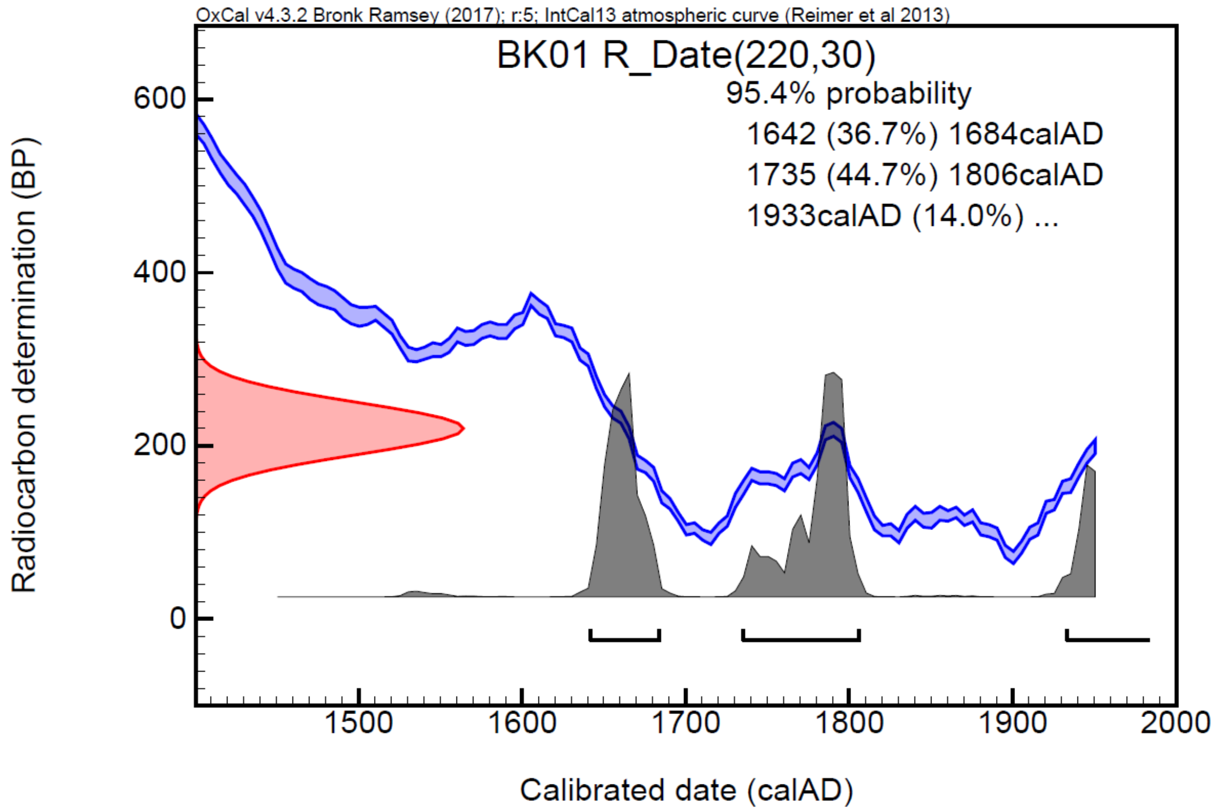

Figure F.5: Calibrated date ranges for radiocarbon sample BK01.

Appendix G Multivariate Analysis Results

In Appendix G, I include the following:

- Multidimensional Scaling List of Variables
- Multidimensional Scaling Similarity Matrix
- Multidimensional Scaling Coding Key
- Multidimensional Scaling
- Stress Calculations for Dimensions 1-5
- Multidimensional Scaling Declining Stress Level Plot
- Multidimensional Scaling Scatter Plots for all 20 Variables
- Principal Components Analysis (PCA) List of Cases and Variables
- Systat Output of PCA (Factor Analysis)
- PCA Scree Plot
- PCA Results
- Hierarchical Cluster Analysis List of Cases and Variables
- Hierarchical Cluster Analysis Similarity Matrix
- Systat Output of Hierarchical Cluster Analysis

Table G.1: MDS List of Variables (Part 1 of 2).

Unit	Sherd Density	Lithic/ Sherds	Bones/ Sherds	Serve %	Cook %	Store %	House Quality Rank	Niche #	Plaster Presence	Exotic Presence	Tools/ Tokens Presence	High Status Food Presence	Majolica Presence	Majolica #
UE4	0.14	0.00	1.33	0.17	0.17	0.17	3	999	0	0	0	0	0	0
UE6	0.74	0.00	0.13	0.03	0.00	0.23	999	0	0	0	0	0	0	0
UE7	0.17	0.00	0.00	0.71	0.00	0.00	999	0	0	0	0	0	0	0
UE8	1.62	0.00	0.25	0.00	0.00	0.82	999	0	0	0	0	0	0	0
UE9	1.69	0.01	0.14	0.54	0.06	0.01	3	999	0	0	0	0	0	0
UE10	0.48	0.00	0.70	0.35	0.05	0.00	3	999	0	0	0	0	0	0
UE11	2.88	0.05	0.60	0.17	0.03	0.11	3	999	0	1	1	0	1	2
UE12	0.40	0.00	0.00	0.00	0.12	0.00	3	999	0	0	0	0	0	0
UE13	3.69	0.07	0.48	0.01	0.00	0.64	1	4	1	0	0	0	1	1
UE14	4.02	0.01	0.18	0.01	0.01	0.79	2	0	0	0	1	0	0	0
UE15	0.69	0.00	0.28	0.17	0.17	0.28	2	1	0	0	1	0	0	0
UE16	0.40	0.00	0.41	0.12	0.06	0.06	2	1	0	0	0	0	0	0
UE17	0.29	0.08	0.75	0.17	0.00	0.08	1	1	1	0	1	0	1	1
UE18	0.14	0.00	2.67	0.00	0.00	0.17	1	1	1	0	0	0	0	0
UE19	2.24	0.06	0.98	0.03	0.29	0.04	1	1	1	1	0	1	0	0
UE20	0.36	0.00	0.13	0.00	0.00	0.27	1	4	1	0	1	0	1	1
UE21	6.33	0.01	0.95	0.06	0.02	0.67	1	4	1	0	0	1	1	7
UE23	10.95	0.00	1.01	0.13	0.10	0.17	999	0	0	1	1	1	1	19
UE24	5.21	0.06	0.84	0.05	0.04	0.25	1	2	1	0	1	1	1	1
UE25	12.67	0.01	0.33	0.07	0.05	0.22	999	0	0	0	0	0	1	14

Table G.2: (Continued) MDS List of Variables (Part 2 of 2).

Unit	Olive Jar Presence	Olive Jar #	Inka-like Ceramic #	Colonial Ceramic #	Local Ceramic #	Mercury Pot #
UE4	0	0	0	0	2	0
UE6	0	0	0	4	0	4
UE7	0	0	0	0	0	0
UE8	0	0	0	26	3	26
UE9	0	0	0	3	35	0
UE10	0	0	1	0	4	0
UE11	0	0	0	12	45	8
UE12	0	0	0	0	2	0
UE13	1	2	1	4	26	1
UE14	0	0	0	19	3	19
UE15	1	1	1	1	8	0
UE16	0	0	0	0	2	0
UE17	0	0	0	2	1	1
UE18	0	0	0	0	1	0
UE19	0	0	0	0	25	0
UE20	0	0	0	1	1	0
UE21	1	3	1	12	9	2
UE23	1	1	0	24	112	4
UE24	1	14	43	28	39	13
UE25	1	2	0	28	75	11

MDS Similarity Matrix Using 20 Variables and a Mixed Variable Coefficient

1.0000																			
0.8622	1.0000																		
0.8276	0.8754	1.0000																	
0.6606	0.8042	0.6796	1.0000																
0.8287	0.8409	0.8977	0.6457	1.0000															
0.9100	0.8763	0.9141	0.6763	0.9091	1.0000														
0.6343	0.6443	0.5803	0.5522	0.6731	0.6561	1.0000													
0.9133	0.9068	0.8795	0.7052	0.8688	0.9204	0.6312	1.0000												
0.5352	0.6053	0.5185	0.5301	0.5606	0.5510	0.5954	0.5554	1.0000											
0.6207	0.7632	0.6475	0.8585	0.6326	0.6341	0.6582	0.6601	0.5431	1.0000										
0.7810	0.7605	0.7139	0.6085	0.7042	0.7447	0.6280	0.7615	0.6048	0.7119	1.0000									
0.8891	0.9058	0.8806	0.7198	0.8521	0.9167	0.6372	0.9157	0.5847	0.7079	0.8129	1.0000								
0.6198	0.6795	0.6512	0.5272	0.6001	0.6388	0.7126	0.6121	0.7433	0.6117	0.6758	0.6994	1.0000							
0.7627	0.8092	0.7526	0.6416	0.6585	0.7371	0.5153	0.7399	0.6519	0.6018	0.6702	0.8083	0.7513	1.0000						
0.6231	0.6127	0.5763	0.4715	0.5816	0.5909	0.5815	0.6143	0.6160	0.4827	0.5887	0.6609	0.6794	0.7073	1.0000					
0.6563	0.7219	0.6571	0.5760	0.6276	0.6657	0.6671	0.6947	0.7637	0.6419	0.7004	0.7013	0.8519	0.7690	0.5999	1.0000				
0.5165	0.5545	0.4722	0.5179	0.4978	0.5201	0.5369	0.5075	0.8263	0.5380	0.5657	0.5446	0.6252	0.6136	0.5949	0.7030	1.0000			
0.4478	0.4699	0.4040	0.4237	0.4274	0.4268	0.6573	0.4237	0.4578	0.5011	0.5683	0.4599	0.4977	0.4005	0.5009	0.4808	0.5954	1.0000		
0.3403	0.4088	0.3223	0.4118	0.3568	0.3483	0.5465	0.3367	0.6399	0.4917	0.5056	0.4069	0.6214	0.4600	0.5297	0.5834	0.6770	0.5734	1.0000	
0.4992	0.6001	0.4987	0.5900	0.5333	0.5136	0.5950	0.5198	0.5814	0.5708	0.5782	0.5613	0.4932	0.4691	0.3965	0.5105	0.6214	0.7325	0.5585	1.0000

Figure G.1: Similarity matrix for MDS.

Table G.3: MDS Coding Key.

Variable	Code	Explanation
Sherd Density	Sherds per unit/excavated area (m)	Total area 42 square meters
Lithics/Sherds	Lithics per unit/total sherds	
Bones/Sherds	Bones per unit/total sherds	
Serving %	Serving shreds/total sherds	
Cooking %	Cooking sherds/total sherds	
Storage %	Storage sherds/total sherds	
House Ranks	1=good, 2=medium, 3=bad	1 is best, 3 is worst
Niche Count	Count of niches per house	
Plaster Presence	presence=1, absence=0	
Exotic Presence	presence=1, absence=0	Beads, jewelry, coins, figurines
Tools/Tokens Presence	presence=1, absence=0	
High Status Food Presence	presence=1, absence=0	Guinea pig, fish, pig, peaches, grapes
Majolica Presence	presence=1, absence=0	
Majolica Count	Total count per unit	
Oliva Jar Presence	presence=1, absence=0	
Olive Jar Count	Total count per unit	
Inka-like Sherd Count	Total count per unit	
Colonial Sherd Count	Total count per unit	
Local Sherd Count	Total count per unit	
Mercury Pot Count	Total count per unit	Trapiche Rim Form 1-5
999 represents missing data, 20 total variables		

Table G.4: Dimension 1, Monotonic Multidimensional Scaling, Kruskal Method, Similarities.

Iteration	Stress
0	0.357
1	0.300
2	0.291
3	0.290
4	0.290

Table G.5: Dimension 2 Monotonic Multidimensional Scaling, Kruskal Method, Similarities.

Iteration	Stress
0	0.176
1	0.143
2	0.129
3	0.123
4	0.121
5	0.119
6	0.119

Table G.6: Dimension 3 Monotonic Multidimensional Scaling, Kruskal Method, Similarities.

Iteration	Stress
0	0.107
1	0.092
2	0.085
3	0.082
4	0.080
5	0.078
6	0.077

Table G.7: Dimension 4 Monotonic Multidimensional Scaling, Kruskal Method, Similarities.

Iteration	Stress
0	0.084
1	0.073
2	0.067
3	0.064

Table G.8: Dimension 5 Monotonic Multidimensional Scaling, Kruskal Method, Similarities.

Iteration	Stress
0	0.100
1	0.080
2	0.070
3	0.065
4	0.061
5	0.057

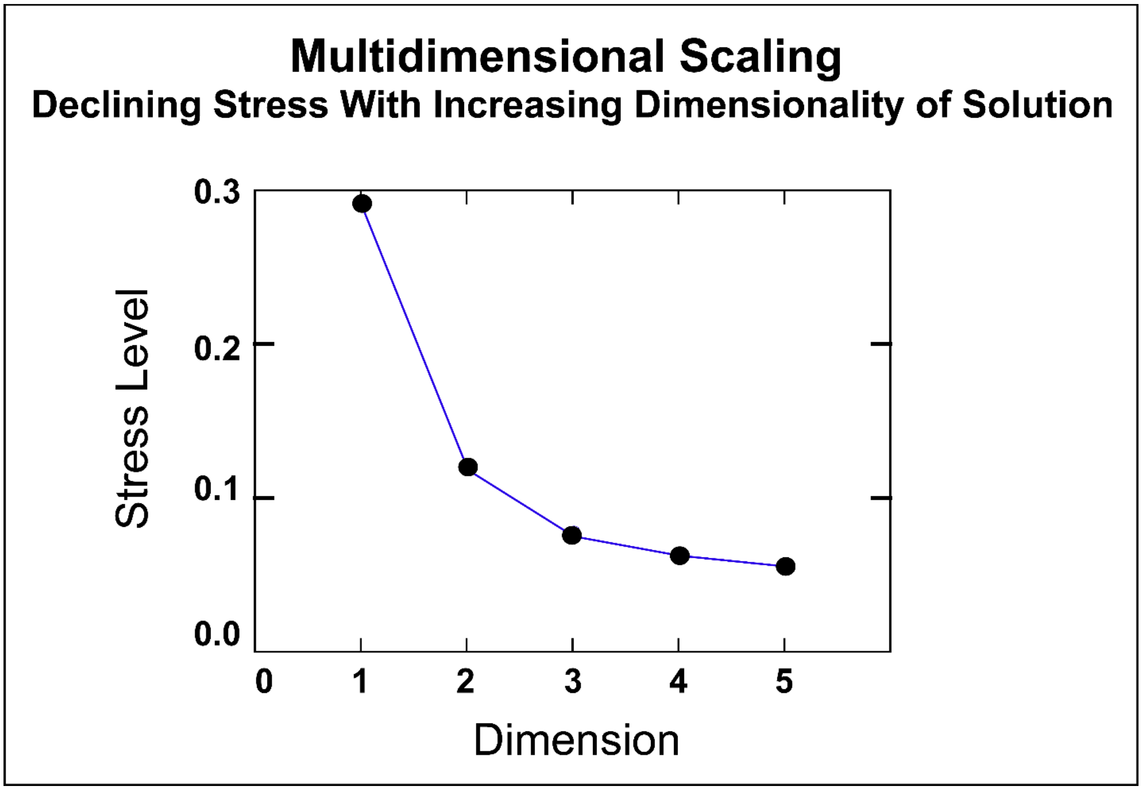

Figure G.2: MDS declining stress plot.

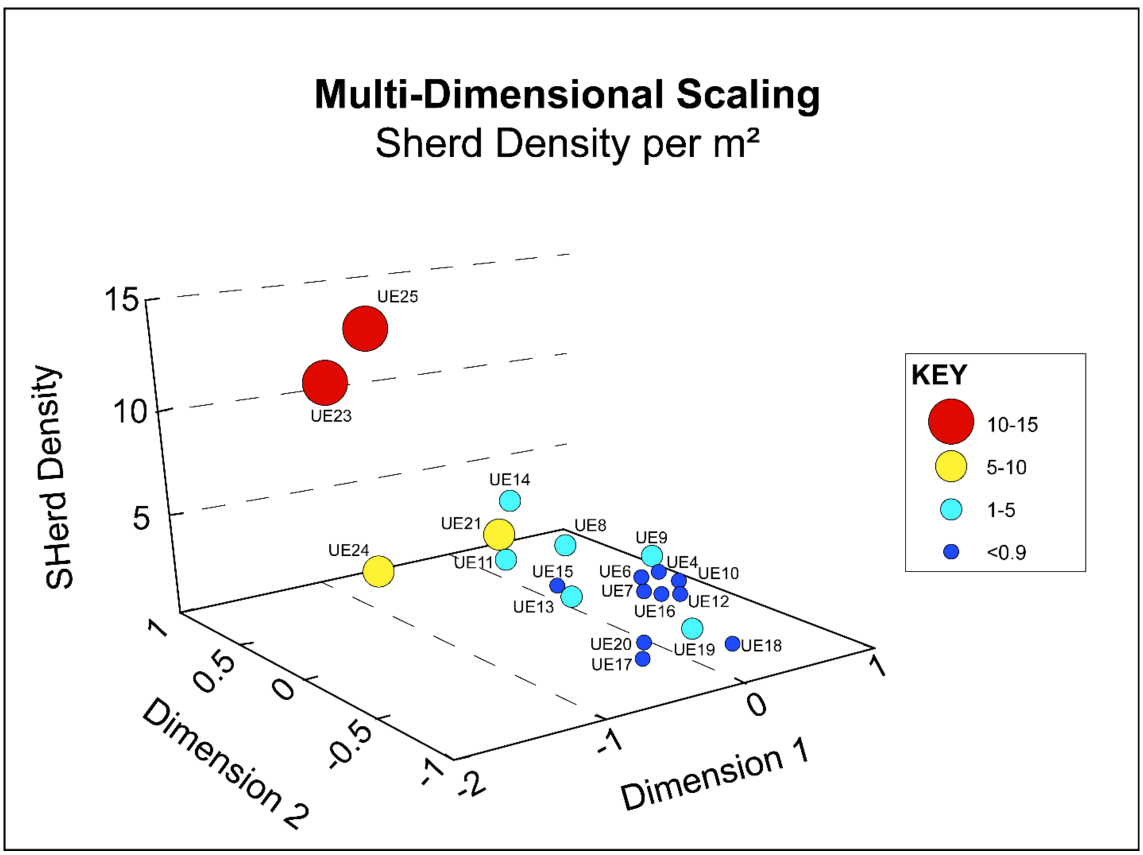

Figure G.3: MDS sherd density per square meter of excavated soil.

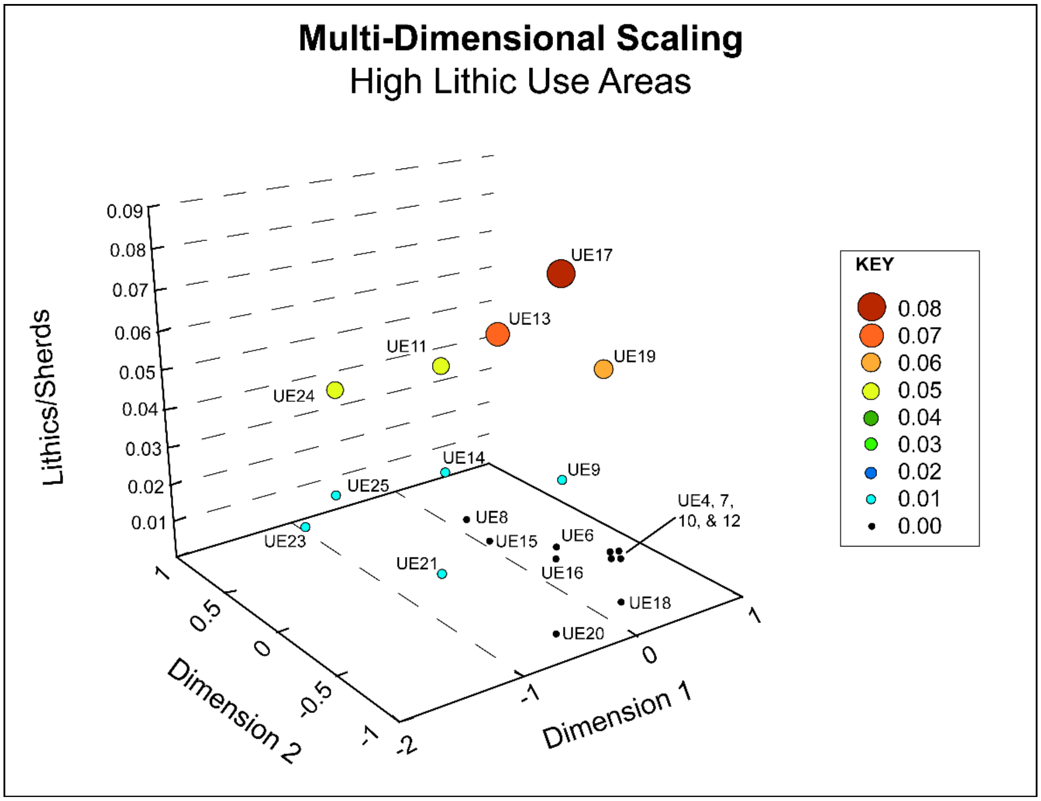

Figure G.4: MDS lithic use areas.

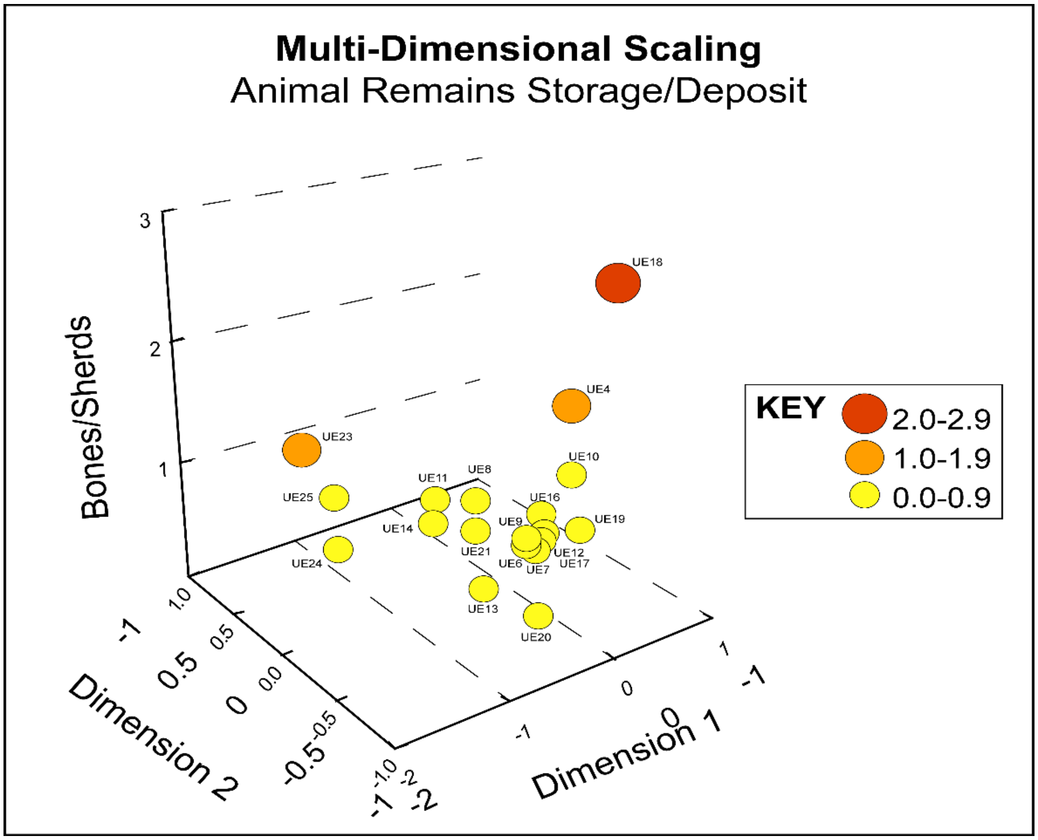

Figure G.5: MDS animals remains per ceramics.

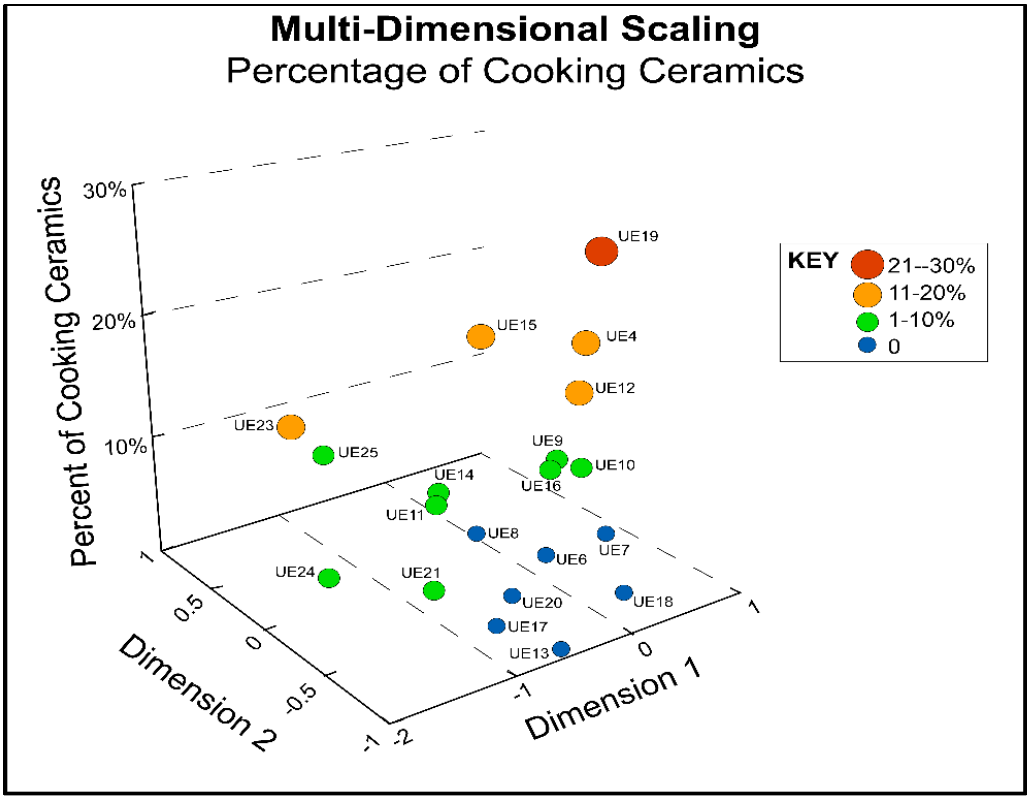

Figure G.6: MDS of cooking ceramic proportions.

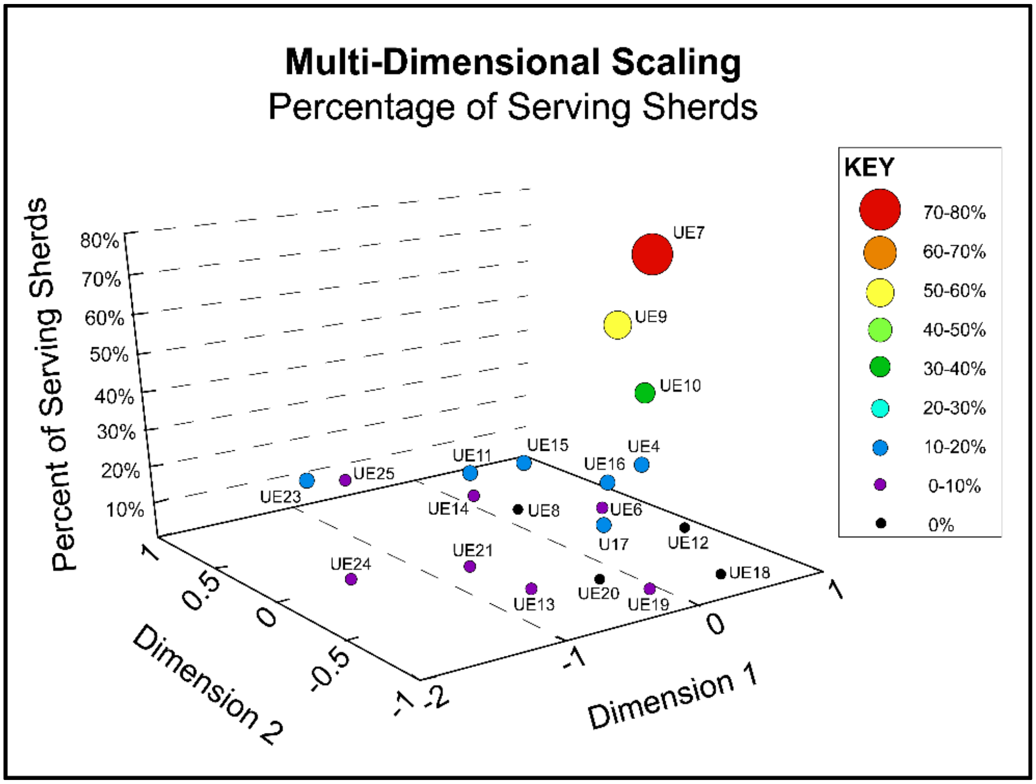

Figure G.7: MDS of serving ceramic proportions.

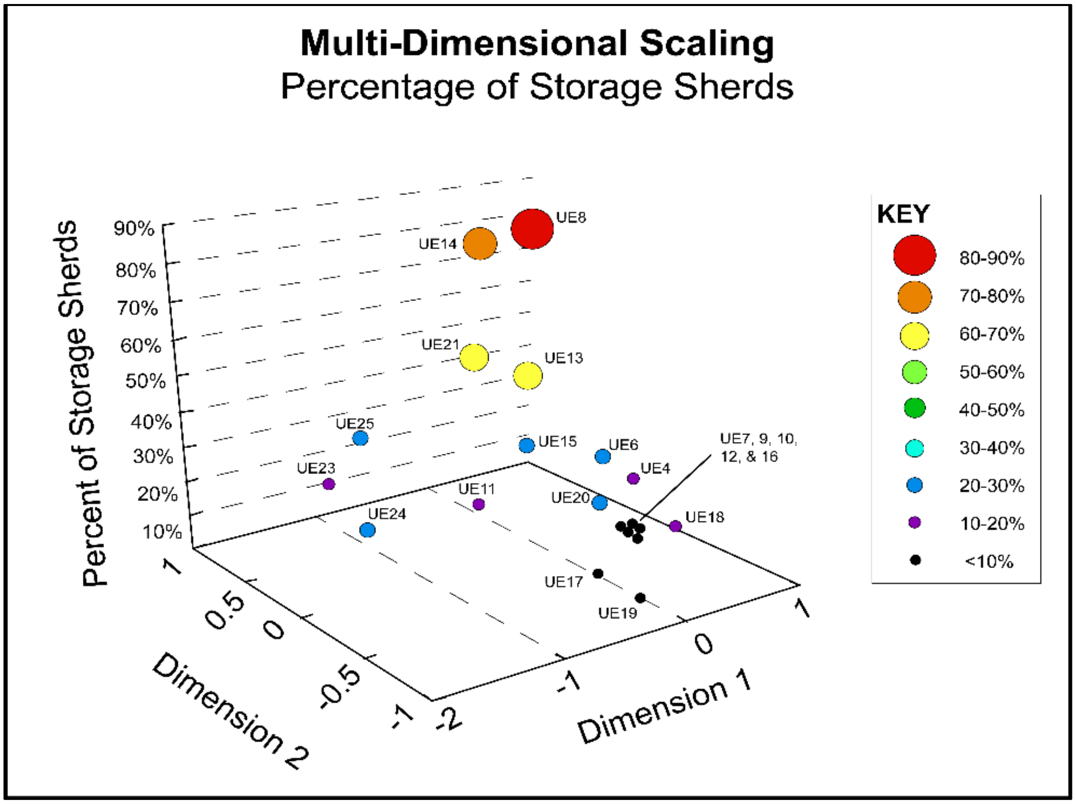

Figure G.8: MDS of storage ceramic proportions.

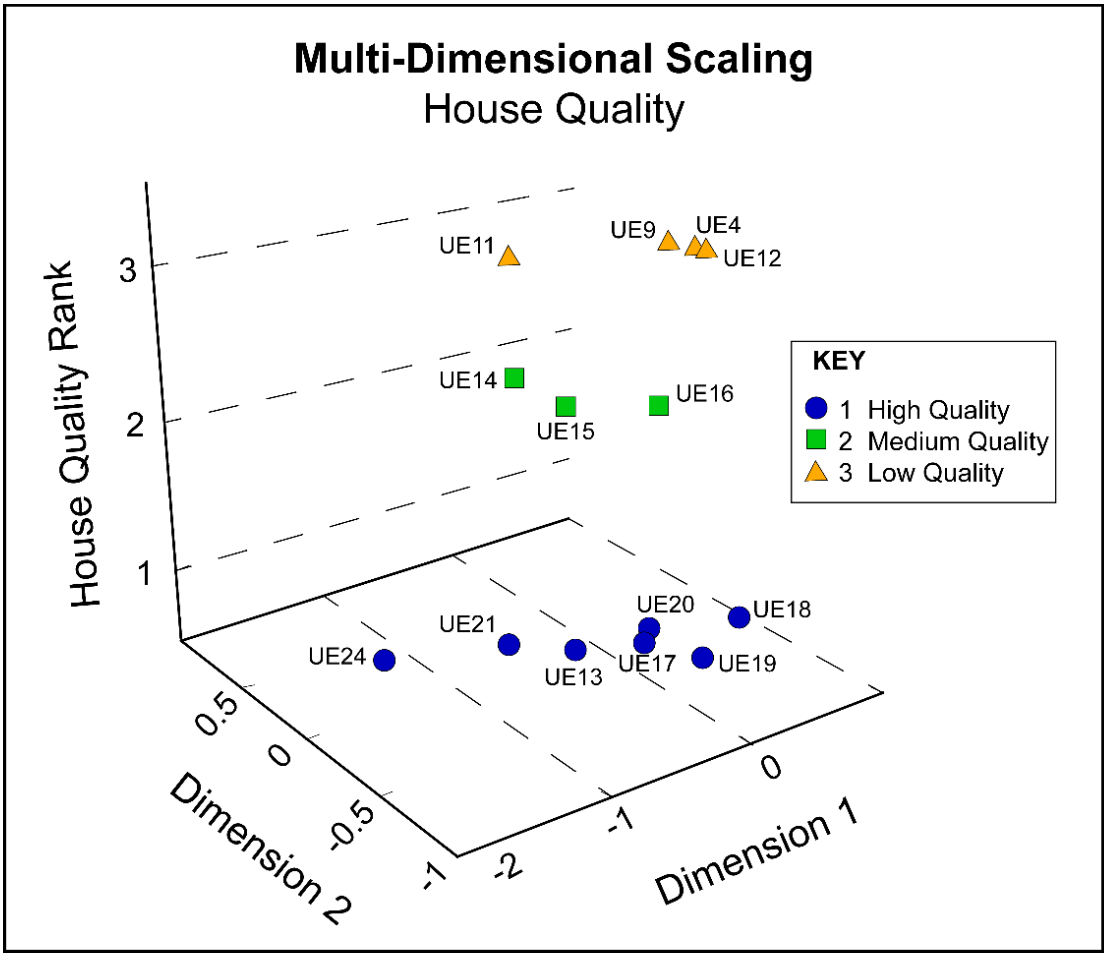

Figure G.9: MDS of house quality.

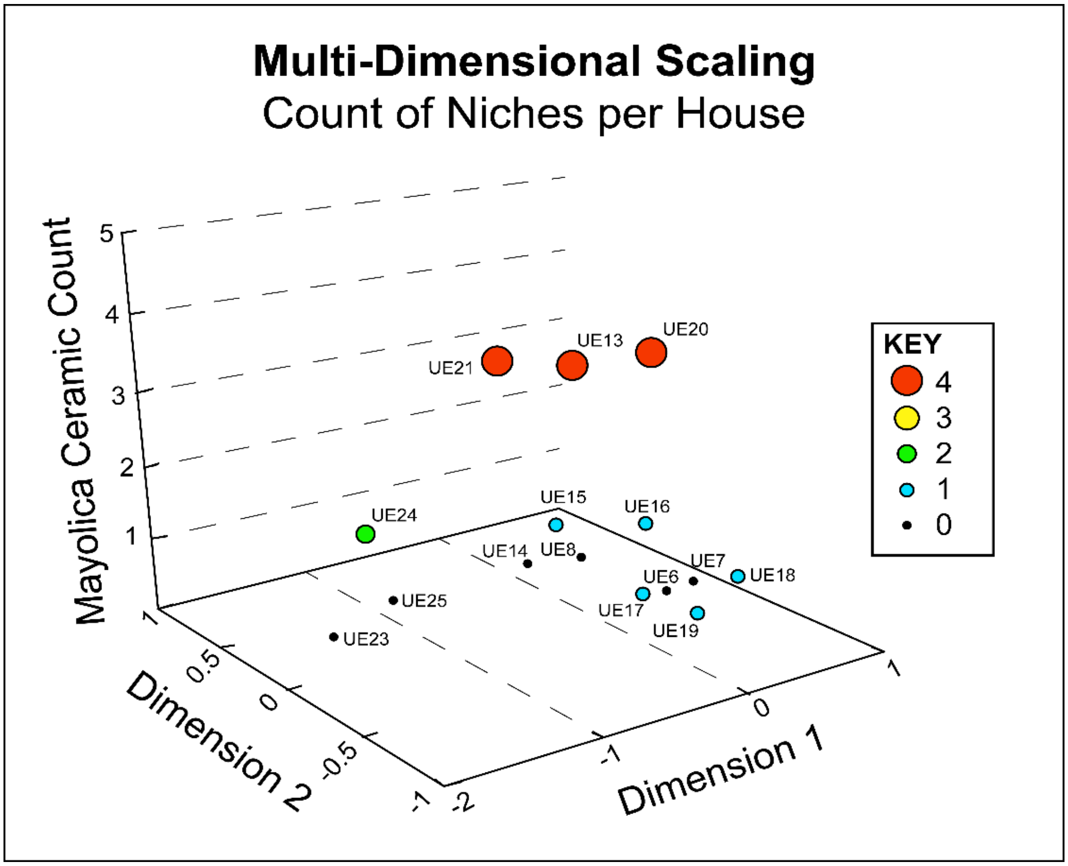

Figure G.10: MDS of niche count per house.

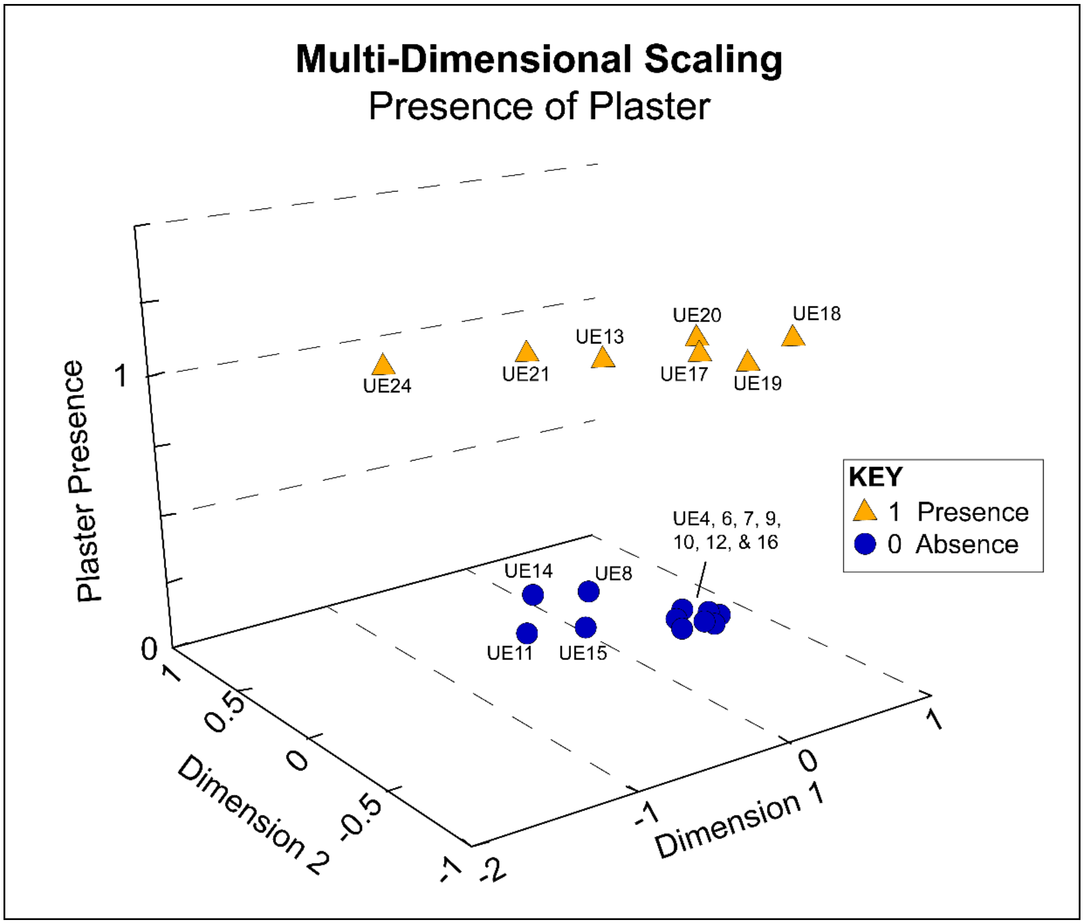

Figure G.11: MDS of plaster presence in houses.

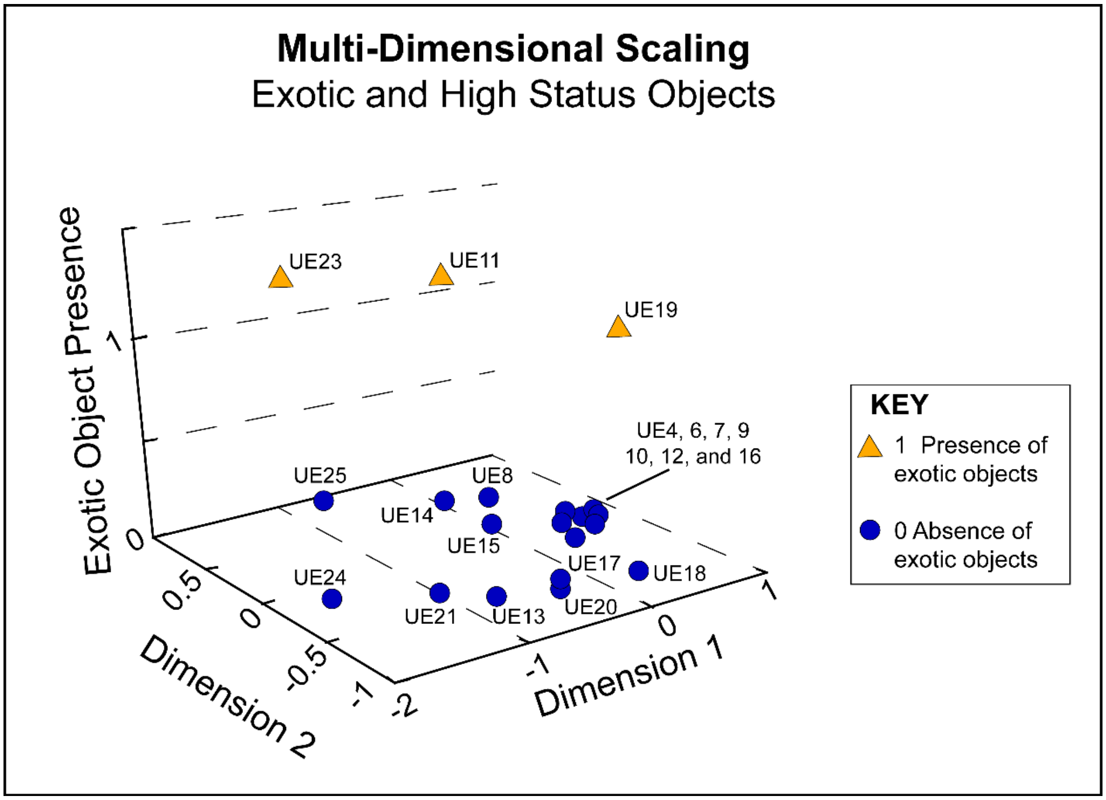

Figure G.12: MDS of high status object presence.

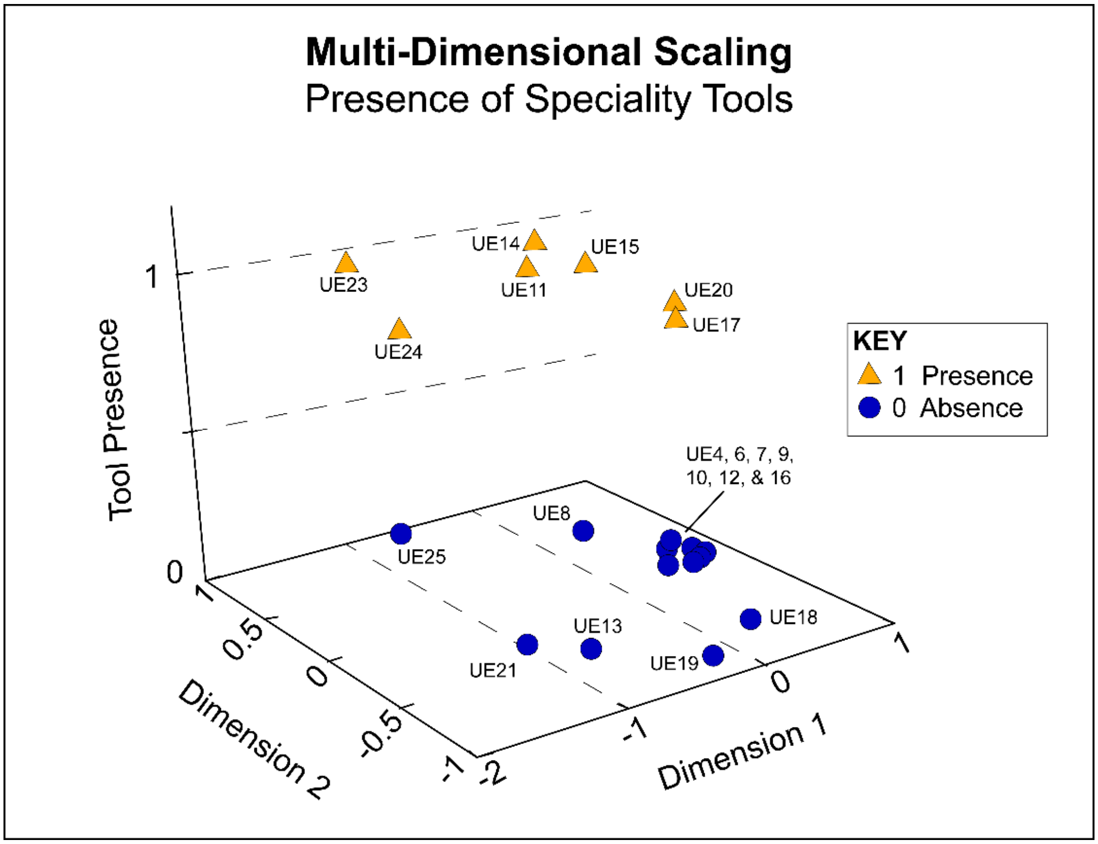

Figure G.13: MDS of specialty tool presence.

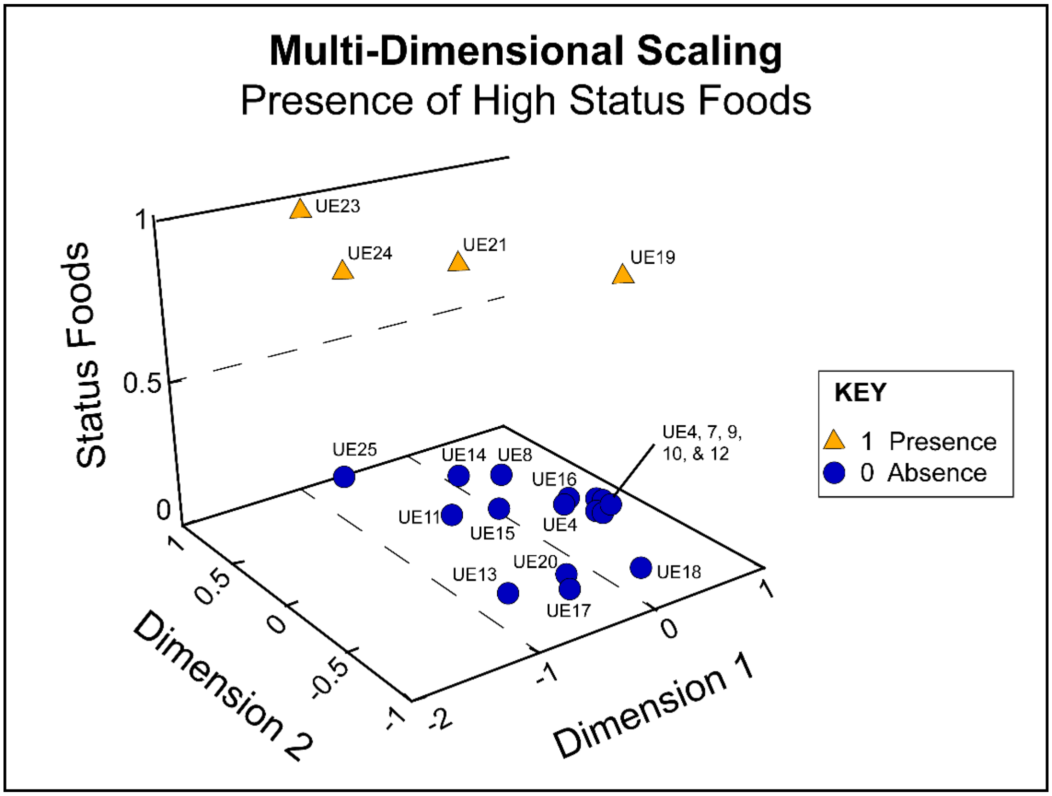

Figure G.14: MDS of high status food presence.

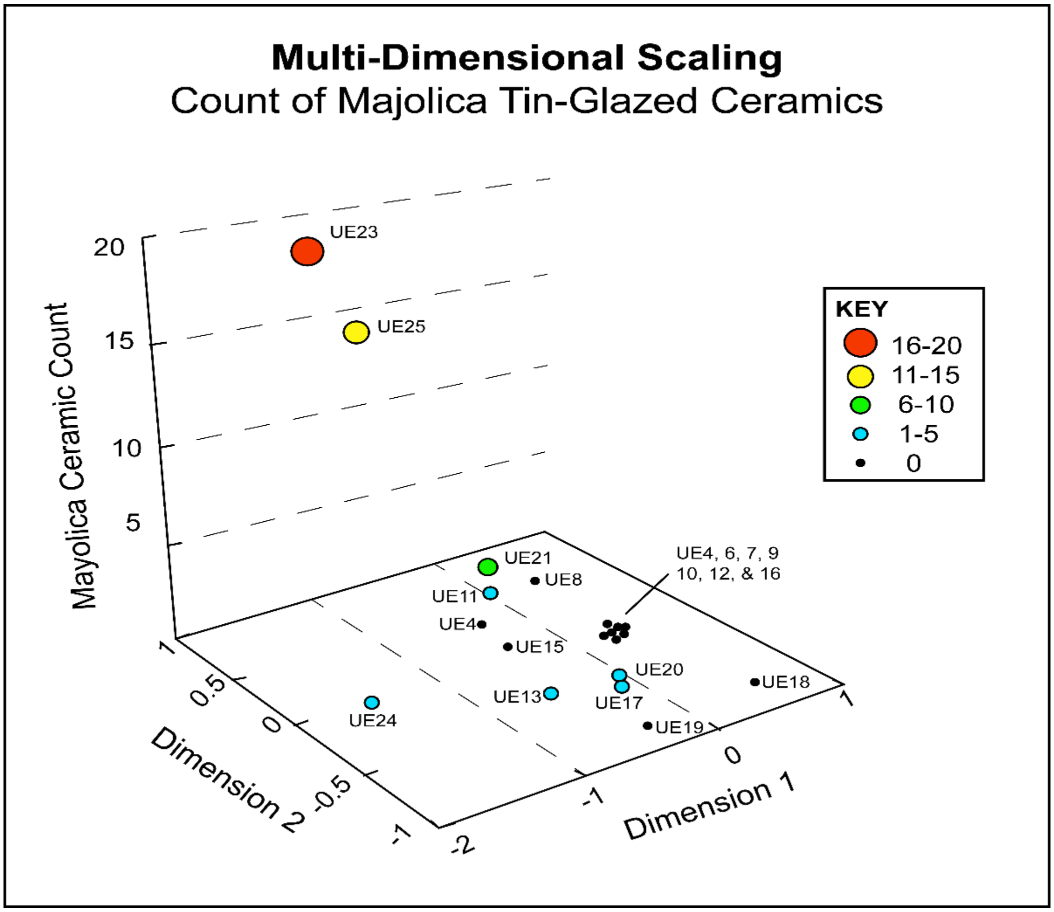

Figure G.15: MDS of majolica count.

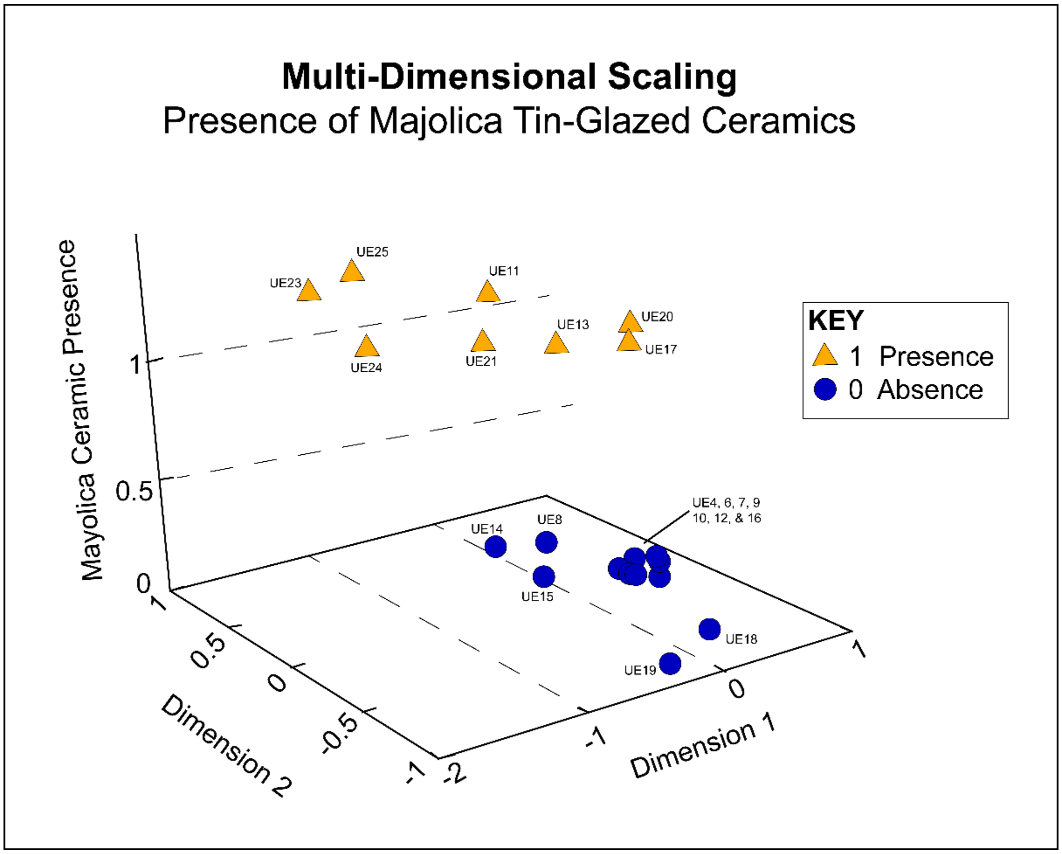

Figure G.16: MDS of majolica presence.

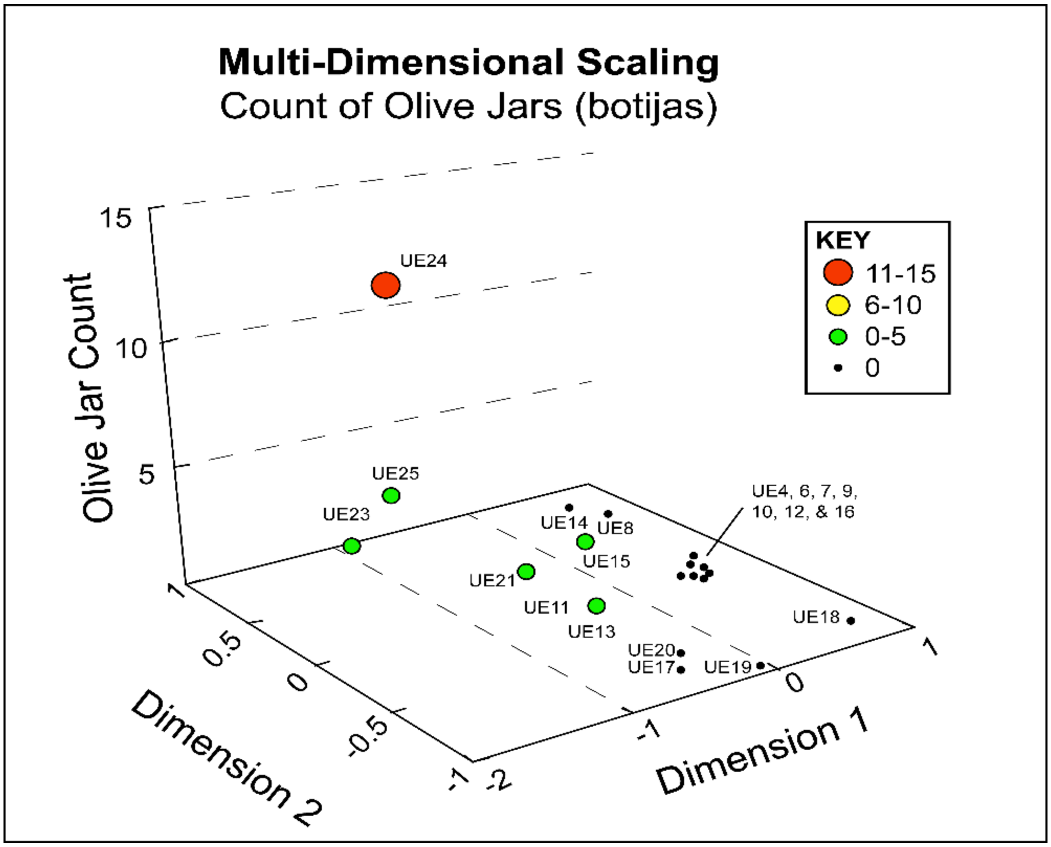

Figure G.17: MDS of olive jar count.

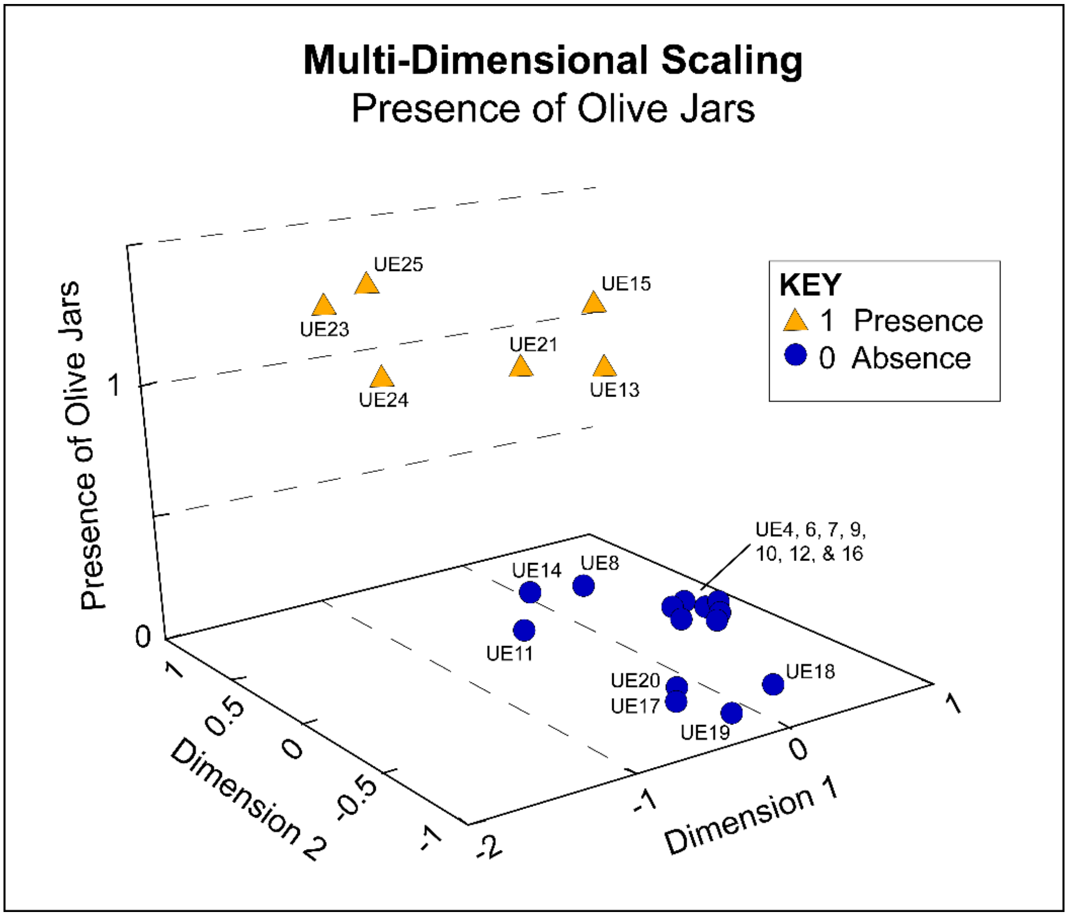

Figure G.18: MDS of olive jar presence.

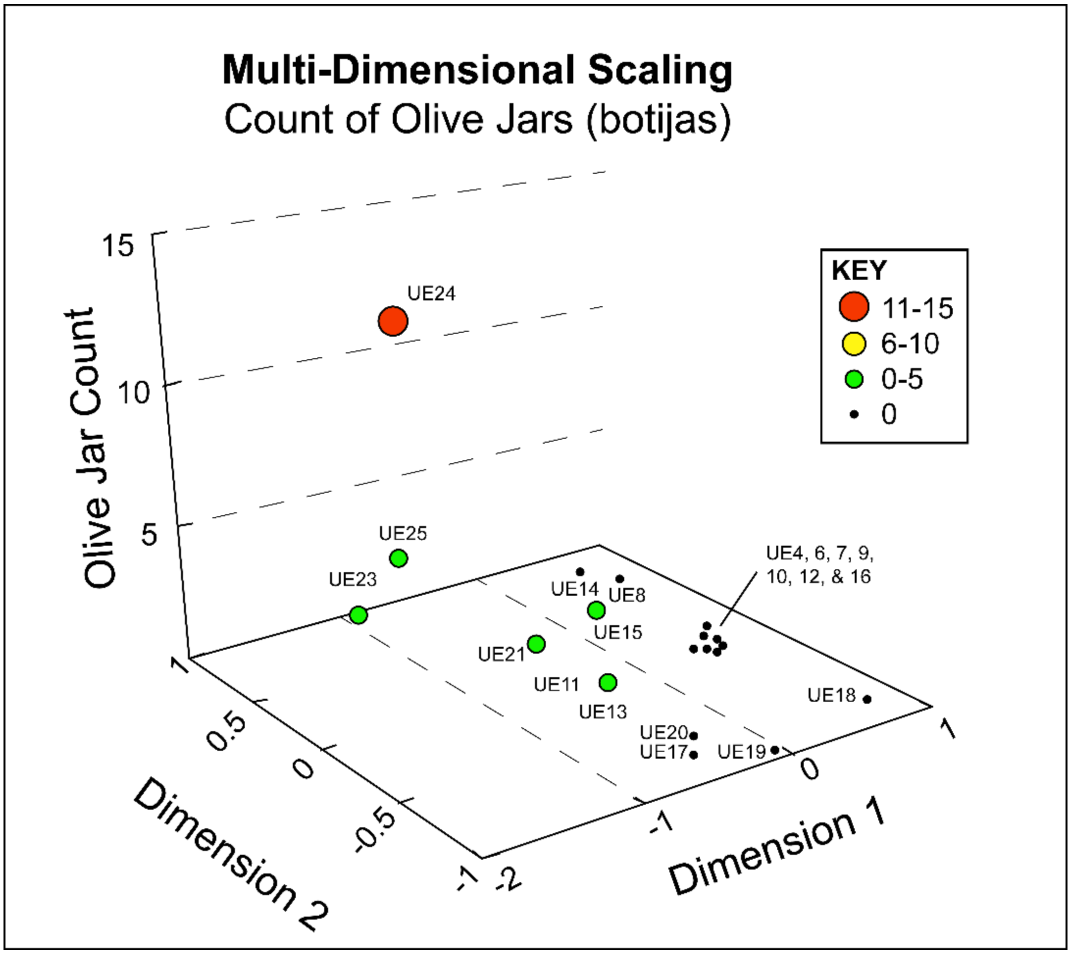

Figure G.19: MDS of olive jar count.

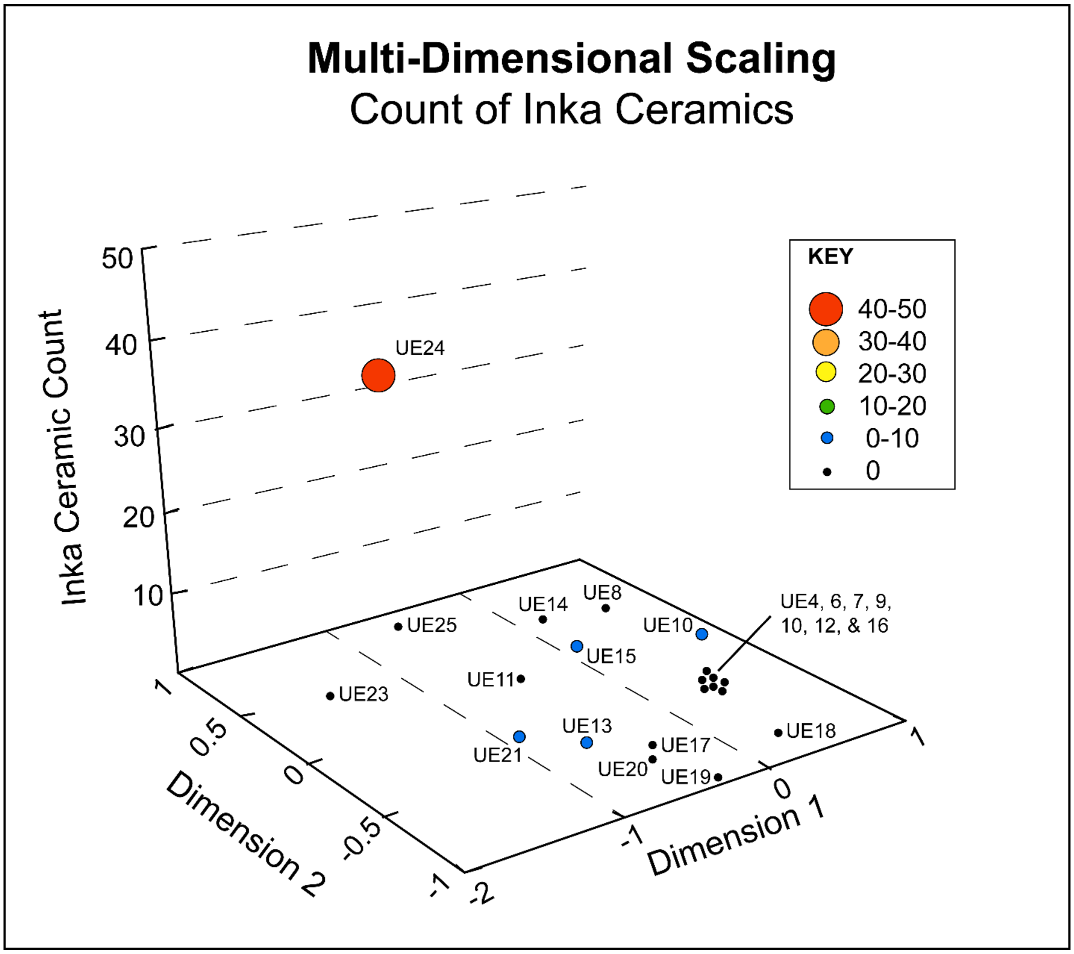

Figure G.20: MDS of Inka-like ceramic count.

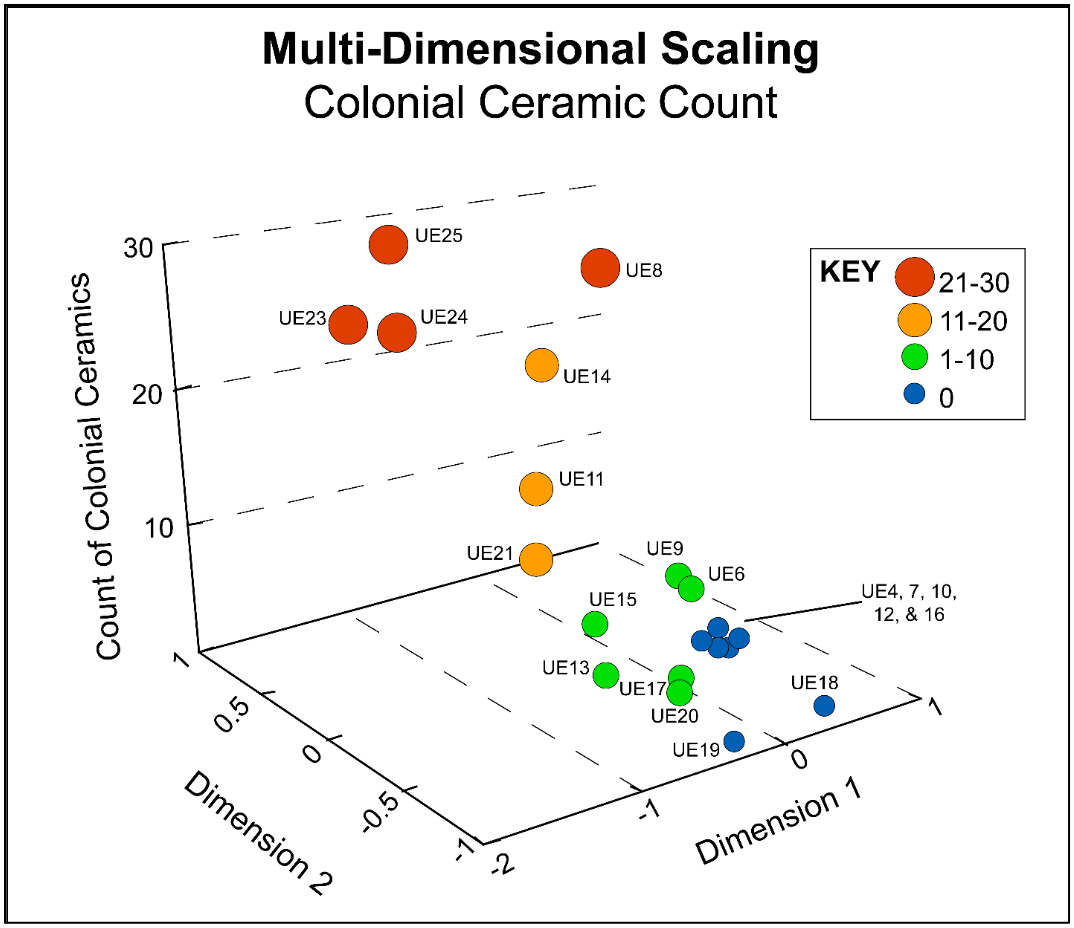

Figure G.21: MDS of colonial ceramic count.

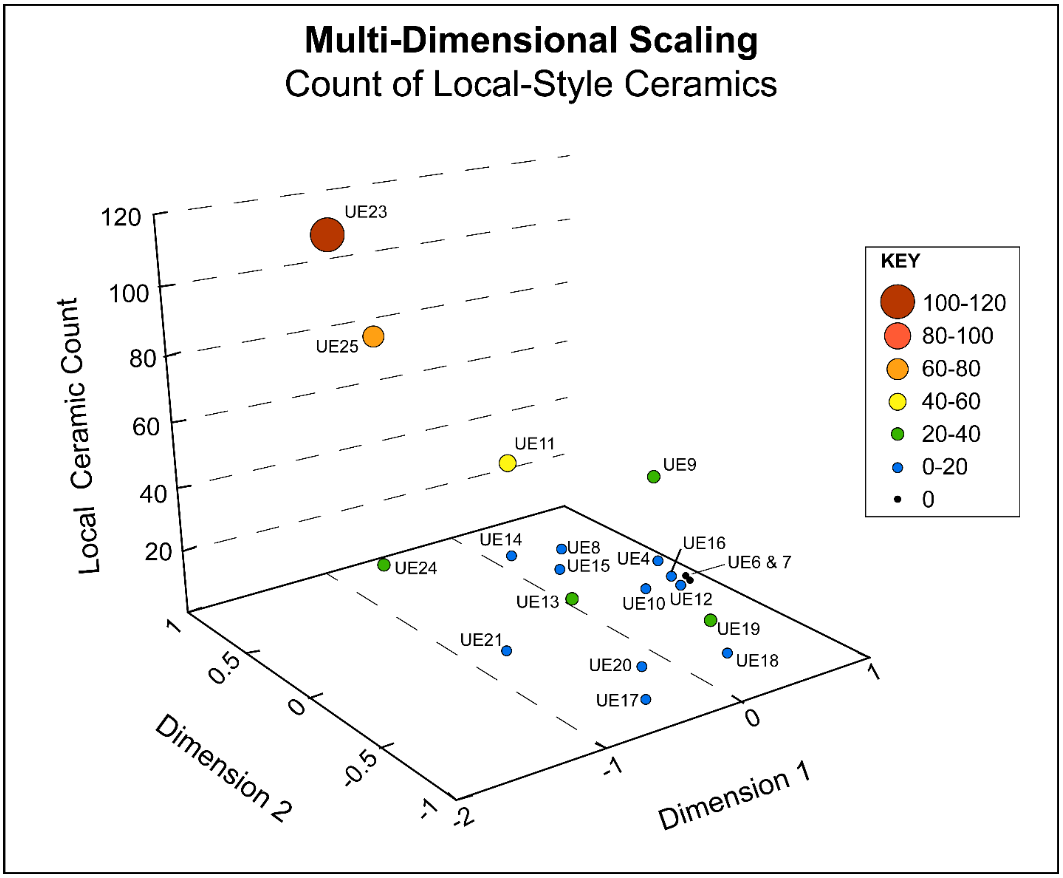

Figure G.22: MDS of local ceramic count.

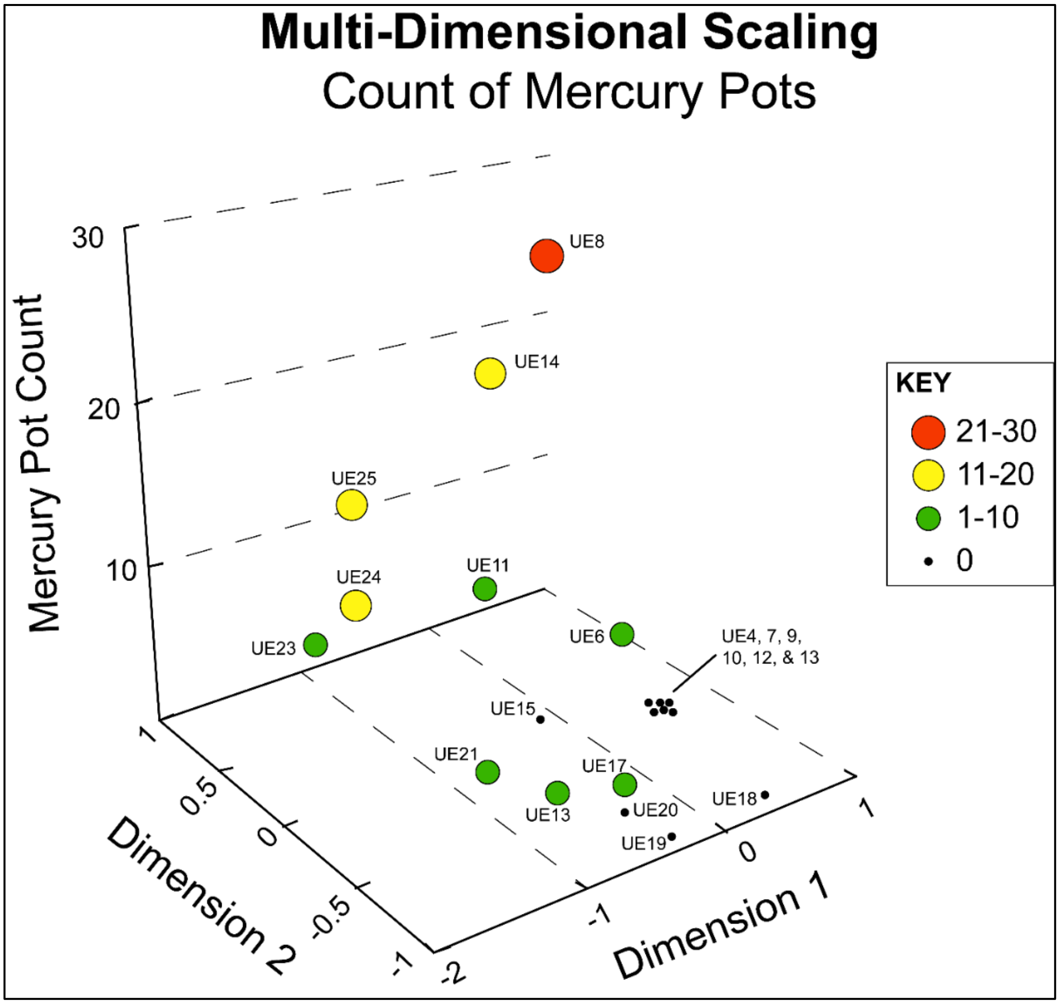

Figure G.23: MDS of mercury pot count.

Table G.9: PCA Description of Variables (Part 1 of 2).

Unit	Sherd Density	Lithic/ Sherds	Bones/ Sherds	Serving %	Cooking %	Storage %	House Quality Rank	Niche #	Plaster Presence	Tools/ Tokens Presence	High Status Food Presence	Majolica #
UE4	0.143	0.000	1.333	0.167	0.167	0.167	0	0	0	0	0	0
UE6	0.738	0.000	0.129	0.032	0.000	0.226	0	0	0	0	0	0
UE7	0.167	0.000	0.000	0.714	0.000	0.000	0	0	0	0	0	0
UE8	1.619	0.000	0.250	0.000	0.000	0.824	0	0	0	0	0	0
UE9	1.690	0.014	0.141	0.535	0.056	0.014	3	0	0	0	0	0
UE10	0.476	0.000	0.700	0.350	0.050	0.000	3	0	0	0	0	0
UE11	2.881	0.050	0.603	0.165	0.033	0.107	3	0	0	1	0	2
UE12	0.405	0.000	0.000	0.000	0.118	0.000	3	0	0	0	0	0
UE13	3.690	0.071	0.484	0.013	0.000	0.639	1	4	1	0	0	1
UE14	4.024	0.012	0.183	0.012	0.012	0.787	2	0	0	1	0	0
UE15	0.690	0.000	0.276	0.172	0.172	0.276	2	1	0	1	0	0
UE16	0.405	0.000	0.412	0.118	0.059	0.059	2	1	0	0	0	0
UE17	0.286	0.083	0.750	0.167	0.000	0.083	1	1	1	1	0	1
UE18	0.143	0.000	2.667	0.000	0.000	0.167	1	1	1	0	0	0
UE19	2.238	0.064	0.979	0.032	0.287	0.043	1	1	1	0	1	0
UE20	0.357	0.000	0.133	0.000	0.000	0.267	1	4	1	1	0	1
UE21	6.333	0.011	0.955	0.056	0.019	0.665	1	4	1	0	1	7
UE23	10.952	0.004	1.011	0.135	0.098	0.165	0	0	0	1	1	19
UE24	5.214	0.059	0.845	0.055	0.041	0.247	1	2	1	1	1	1
UE25	12.667	0.006	0.335	0.066	0.051	0.224	0	0	0	0	0	14

Table G.10: (Continued) PCA List of Variables (Part 2 of 2).

Unit	Olive Jar #	Inka Ceramic #	Colonial Ceramic #	Local Ceramic #	Mercury Pot #
UE4	0	0	0	2	0
UE6	0	0	4	0	4
UE7	0	0	0	0	0
UE8	0	0	26	3	26
UE9	0	0	3	35	0
UE10	0	1	0	4	0
UE11	0	0	12	45	8
UE12	0	0	0	2	0
UE13	2	1	4	26	1
UE14	0	0	19	3	19
UE15	1	1	1	8	0
UE16	0	0	0	2	0
UE17	0	0	2	1	1
UE18	0	0	0	1	0
UE19	0	0	0	25	0
UE20	0	0	1	1	0
UE21	3	1	12	9	2
UE23	1	0	24	112	4
UE24	14	43	28	39	13
UE25	2	0	28	75	11

Table G.11: PCA Factor Analysis Laten Roots (Eigenvalues).

Latent Roots	Values
1	**4.725**
2	**3.011**
3	**2.314**
4	**1.762**
5	**1.149**
6	**1.074**
7	0.817
8	0.692
9	0.599
10	0.420

Table G.12: PCA Component Loadings 1-9.

Variables	1	2	3	4	5	6	7	8	9
SHERD_DEN	0.812	-0.420	0.198	-0.164	0.138	-0.090	0.087	0.035	0.162
LITHIC_SHERD	0.312	0.557	0.130	0.212	0.318	0.108	-0.105	-0.581	0.234
BONES_SHERDS	0.149	0.336	0.341	-0.389	-0.353	0.131	-0.607	0.155	0.127
SERVING_PERC	-0.412	-0.265	0.284	0.396	-0.047	-0.560	0.034	-0.206	-0.015
COOKING_PERC	-0.080	-0.003	0.620	0.030	-0.171	0.629	0.338	-0.102	-0.140
STORAGE_PERC	0.410	0.039	-0.741	-0.336	0.053	0.129	0.179	-0.012	0.036
HOUSE_LVL	-0.392	0.095	0.060	0.488	0.384	0.265	0.035	0.389	0.451
NICHE_COUNT	0.260	0.708	-0.114	-0.335	0.300	-0.254	0.298	0.189	-0.032
PLASTER	0.306	0.862	0.076	-0.275	0.096	-0.095	-0.073	-0.089	0.033
TOOLS	0.385	0.095	-0.054	0.389	0.537	0.181	-0.314	0.104	-0.494
FOOD	0.678	0.236	0.447	-0.035	-0.158	0.100	0.258	0.020	-0.063
MAYOLICA_COUNT	0.643	-0.512	0.374	-0.305	0.197	-0.156	-0.028	0.101	-0.026
OLIVE_COUNT	0.697	0.385	0.002	0.455	-0.279	-0.167	0.090	0.144	0.018
INKA_COUNT	0.574	0.406	-0.016	0.591	-0.338	-0.104	0.001	0.122	-0.037
COLONIAL_COUNT	0.861	-0.377	-0.276	0.122	-0.079	0.033	-0.045	-0.018	0.074
LOCAL_COUNT	0.670	-0.450	0.474	0.028	0.215	-0.040	-0.066	-0.032	0.118
MERCURY_COUNT	0.509	-0.319	-0.680	0.160	-0.163	0.241	-0.075	-0.153	0.068

Table G.13: PCA Variance Explained by Components 1-9.

Type	1	2	3	4	5	6	7	8	9
Variance	4.725	3.011	2.314	1.762	1.149	1.074	0.817	0.692	0.599
Percent of Total Variance	27.794	17.713	13.611	10.365	6.759	6.320	4.805	4.073	3.523

Table G.14: PCA Rotated Loading Matrix, ORTHOMAX, Gamma = 0.1, Component Loadings 1-9.

Variables	1	2	3	4	5	6	7	8	9
SHERD_DEN	0.028	-0.118	-0.160	-0.038	-0.032	-0.955	0.044	0.041	-0.047
LITHIC_SHERD	0.027	0.260	0.853	-0.011	-0.041	0.203	-0.142	-0.021	0.154
BONES_SHERDS	-0.208	-0.065	-0.153	-0.028	0.078	-0.028	-0.104	0.038	-0.942
SERVING_PERC	-0.037	0.961	0.110	0.132	0.023	0.097	-0.017	0.086	0.018
COOKING_PERC	-0.106	0.743	0.036	0.225	0.042	0.006	0.367	0.427	0.129
STORAGE_PERC	0.144	0.038	0.085	0.176	0.948	0.035	-0.058	0.131	-0.077
HOUSE_LVL	0.463	0.313	0.023	0.485	-0.014	-0.469	0.132	0.115	0.158
NICHE_COUNT	0.958	0.031	0.004	-0.071	0.082	-0.014	0.064	-0.140	0.171
PLASTER	0.170	0.179	0.101	0.942	0.065	0.021	0.026	0.107	0.017
TOOLS	0.009	0.046	0.051	0.972	0.136	0.007	0.049	0.118	-0.005
FOOD	0.622	-0.229	0.569	0.410	0.098	0.157	-0.076	0.022	0.134
MAYOLICA_COUNT	0.932	-0.143	-0.069	0.107	0.121	-0.097	0.026	0.122	-0.011
OLIVE_COUNT	0.131	-0.397	0.803	0.250	0.067	0.207	-0.148	0.061	0.116
INKA_COUNT	0.028	-0.118	-0.160	-0.038	-0.032	-0.955	0.044	0.041	-0.047
COLONIAL_COUNT	0.027	0.260	0.853	-0.011	-0.041	0.203	-0.142	-0.021	0.154
LOCAL_COUNT	-0.208	-0.065	-0.153	-0.028	0.078	-0.028	-0.104	0.038	-0.942
MERCURY_COUNT	-0.037	0.961	0.110	0.132	0.023	0.097	-0.017	0.086	0.018

Table G.15: PCA Variance Explained by Rotated Components.

Type	1	2	3	4	5	6	7	8	9
Variance	3.399	2.089	2.363	2.478	1.015	1.326	1.265	1.165	1.044
Percent of Total Variance	19.992	12.286	13.901	14.578	5.970	7.800	7.443	6.850	6.143

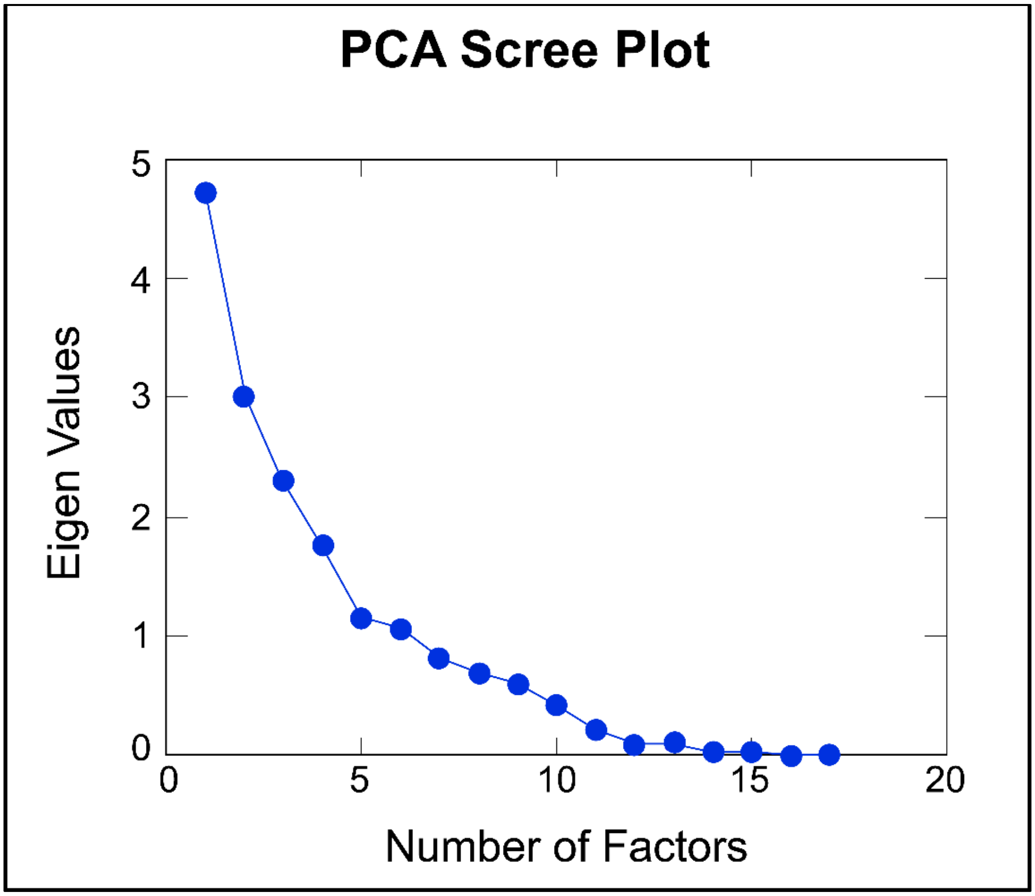

Figure G.24: Scree plot of eigenvalues from PCA.

Table G.16: Variance Explained by Rotated Components.

Components					
1	2	3	4	5	6
3.528	2.642	2.436	2.549	1.356	1.524
Percent of Total Variance Explained					
1	2	3	4	5	6
20.75	15.54	14.327	14.996	7.979	8.966

Table G.17: PCA Rotated Loading Matrix.

Component[29]	1	2	3	4	5	6
Sherd density	0.928	0.004	0.218	0.138	-0.032	-0.017
Lithics/sherds	0.020	0.525	-0.009	0.310	0.438	0.137
Bones/sherds	0.039	0.359	-0.023	0.088	-0.420	0.479
Serving Sherd %	-0.045	-0.369	-0.731	0.055	-0.031	-0.344
Cooking Sherd %	0.040	-0.141	-0.178	-0.042	0.091	0.868
Storage Sherd %	0.033	0.198	0.850	-0.027	-0.084	-0.283
House Quality Rank	-0.336	-0.136	-0.231	-0.090	0.650	0.086
Niche Count	-0.027	0.893	0.100	0.056	0.000	-0.193
Plaster Presence	-0.083	0.926	0.047	0.236	-0.054	0.106
Tool Presence	0.232	0.143	0.159	0.196	0.702	-0.054
High Status Food Presence	0.485	0.335	0.020	0.466	-0.076	0.425
Majolica Sherd Count	0.976	-0.006	0.024	-0.085	-0.107	0.013
Oliver Jar Sherd Count	0.171	0.222	0.097	0.925	0.045	-0.026
Inka Sherd Count	0.017	0.123	0.055	0.969	0.100	0.012
Colonial Sherd Count	0.627	-0.201	0.578	0.435	0.026	-0.156
Local Sherd Count	0.926	-0.094	-0.068	0.130	0.142	0.127
Mercury Pot Sherd Count	0.134	-0.352	0.810	0.300	0.058	-0.208

[29] PCA rotated loading matrix (ORTHOMAX, Gamma = 1.000000).

Table G.18: Hierarchical Cluster Analysis Variable List (Part 1 of 2).

Unit	Sherd Density	Lithic/ Sherds	Bones/ Sherds	Serving %	Cooking %	Storage %	House Quality Rank	Niche #	Plaster Presence	Tools/ Tokens Presence	High Status Food Presence	Majolica #
UE4	0.143	0.000	1.333	0.167	0.167	0.167	0	0	0	0	0	0
UE6	0.738	0.000	0.129	0.032	0.000	0.226	0	0	0	0	0	0
UE7	0.167	0.000	0.000	0.714	0.000	0.000	0	0	0	0	0	0
UE8	1.619	0.000	0.250	0.000	0.000	0.824	0	0	0	0	0	0
UE9	1.690	0.014	0.141	0.535	0.056	0.014	3	0	0	0	0	0
UE10	0.476	0.000	0.700	0.350	0.050	0.000	3	0	0	0	0	0
UE11	2.881	0.050	0.603	0.165	0.033	0.107	3	0	0	1	0	2
UE12	0.405	0.000	0.000	0.000	0.118	0.000	3	0	0	0	0	0
UE13	3.690	0.071	0.484	0.013	0.000	0.639	1	4	1	0	0	1
UE14	4.024	0.012	0.183	0.012	0.012	0.787	2	0	0	1	0	0
UE15	0.690	0.000	0.276	0.172	0.172	0.276	2	1	0	1	0	0
UE16	0.405	0.000	0.412	0.118	0.059	0.059	2	1	0	0	0	0
UE17	0.286	0.083	0.750	0.167	0.000	0.083	1	1	1	1	0	1
UE18	0.143	0.000	2.667	0.000	0.000	0.167	1	1	1	0	0	0
UE19	2.238	0.064	0.979	0.032	0.287	0.043	1	1	1	0	1	0
UE20	0.357	0.000	0.133	0.000	0.000	0.267	1	4	1	1	0	1
UE21	6.333	0.011	0.955	0.056	0.019	0.665	1	4	1	0	1	7
UE23	10.952	0.004	1.011	0.135	0.098	0.165	0	0	0	1	1	19
UE24	5.214	0.059	0.845	0.055	0.041	0.247	1	2	1	1	1	1
UE25	12.667	0.006	0.335	0.066	0.051	0.224	0	0	0	0	0	14

Table G.19: (Continued) Hierarchical Cluster Analysis Variable List (Part 2 of 2).

Unit	Olive Jar #	Inka Ceramic #	Colonial Ceramic #	Local Ceramic #	Mercury Pot #
UE4	0	0	0	2	0
UE6	0	0	4	0	4
UE7	0	0	0	0	0
UE8	0	0	26	3	26
UE9	0	0	3	35	0
UE10	0	1	0	4	0
UE11	0	0	12	45	8
UE12	0	0	0	2	0
UE13	2	1	4	26	1
UE14	0	0	19	3	19
UE15	1	1	1	8	0
UE16	0	0	0	2	0
UE17	0	0	2	1	1
UE18	0	0	0	1	0
UE19	0	0	0	25	0
UE20	0	0	1	1	0
UE21	3	1	12	9	2
UE23	1	0	24	112	4
UE24	14	43	28	39	13
UE25	2	0	28	75	11

HCA Similarity Matrix Using 20 Variables and a Mixed Variable Coefficient

1.0000																			
0.8622	1.0000																		
0.8276	0.8754	1.0000																	
0.6606	0.8042	0.6796	1.0000																
0.8287	0.8409	0.8977	0.6457	1.0000															
0.9100	0.8763	0.9141	0.6763	0.9091	1.0000														
0.6343	0.6443	0.5803	0.5522	0.6731	0.6561	1.0000													
0.9133	0.9068	0.8795	0.7052	0.8688	0.9204	0.6312	1.0000												
0.5352	0.6053	0.5185	0.5301	0.5606	0.5510	0.5954	0.5554	1.0000											
0.6207	0.7632	0.6475	0.8585	0.6326	0.6341	0.6582	0.6601	0.5431	1.0000										
0.7810	0.7605	0.7139	0.6085	0.7042	0.7447	0.6280	0.7615	0.6048	0.7119	1.0000									
0.8891	0.9058	0.8806	0.7198	0.8521	0.9167	0.6372	0.9157	0.5847	0.7079	0.8129	1.0000								
0.6198	0.6795	0.6512	0.5272	0.6001	0.6388	0.7126	0.6121	0.7433	0.6117	0.6758	0.6994	1.0000							
0.7627	0.8092	0.7526	0.6416	0.6585	0.7371	0.5153	0.7399	0.6519	0.6018	0.6702	0.8083	0.7513	1.0000						
0.6231	0.6127	0.5763	0.4715	0.5816	0.5909	0.5815	0.6143	0.6160	0.4827	0.5887	0.6609	0.6794	0.7073	1.0000					
0.6563	0.7219	0.6571	0.5760	0.6276	0.6657	0.6671	0.6947	0.7637	0.6419	0.7004	0.7013	0.8519	0.7690	0.5999	1.0000				
0.5165	0.5545	0.4722	0.5179	0.4978	0.5201	0.5369	0.5075	0.8263	0.5380	0.5657	0.5446	0.6252	0.6136	0.5949	0.7030	1.0000			
0.4478	0.4699	0.4040	0.4237	0.4274	0.4268	0.6573	0.4237	0.4578	0.5011	0.5683	0.4599	0.4977	0.4005	0.5009	0.4808	0.5954	1.0000		
0.3403	0.4088	0.3223	0.4118	0.3568	0.3483	0.5465	0.3367	0.6399	0.4917	0.5056	0.4069	0.6214	0.4600	0.5297	0.5834	0.6770	0.5734	1.0000	
0.4992	0.6001	0.4987	0.5900	0.5333	0.5136	0.5950	0.5198	0.5814	0.5708	0.5782	0.5613	0.4932	0.4691	0.3965	0.5105	0.6214	0.7325	0.5585	1.0000

Figure G.25: HCA showing the similarity matrix.

Table G.20: HCA By Units (Cases) Using Complete Linkage (Farthest Neighbor).

Clusters Joining	Clusters Joining	At Distance	Number of Members
UE14	UE8	1.447	2
UE16	UE12	1.591	2
UE10	UE9	1.633	2
UE7	UE10	1.870	3
UE16	UE6	1.960	3
UE21	UE13	1.977	2
UE20	UE17	2.135	2
UE4	UE16	2.139	4
UE4	UE7	2.365	7
UE19	UE18	2.710	2
UE20	UE11	2.838	3
UE15	UE4	2.868	8
UE25	UE23	3.236	2
UE24	UE21	3.316	3
UE14	UE15	3.492	10
UE14	UE20	3.653	13
UE19	UE24	3.876	5
UE19	UE25	4.513	7
UE14	UE19	5.064	20

Table G.21: HCA For Variables Using Complete Linkage (Farthest Neighbor).

Clusters Joining	Clusters Joining	At Distance	Number of Members
INKA_COUNT	OLIVE_COUNT	0.034	2
MAYOLICA_COUNT	SHERD_DEN	0.100	2
MAYOLICA_COUNT	LOCAL_COUNT	0.151	3
MERCURY_POT_COUNT	COLONIAL_COUNT	0.187	2
PLASTER	NICHE_COUNT	0.223	2
HOUSE_RANK	SERVING_PERC	0.409	2
OLIVE_JAR	MAYOLICA	0.421	2
OLIVE_JAR	MAYOLICA_COUNT	0.468	5
STATUS_FOOD	EXOTIC	0.510	2
STORAGE_PERC	MERCURY_POT_COUNT	0.511	3
STATUS_FOOD	COOKING_PERC	0.643	3
INKA_COUNT	LITHIC_SHERD	0.663	3
TOOLS	INKA_COUNT	0.729	4
BONES_SHERDS	STATUS_FOOD	0.888	4
PLASTER	TOOLS	0.899	6
STORAGE_PERC	OLIVE_JAR	1.104	8
PLASTER	BONES_SHERDS	1.186	10
STORAGE_PERC	PLASTER	1.347	18
STORAGE_PERC	HOUSE_RANK	1.899	20

Table G.22: HCA For Variables Using Average Linkage.

Clusters Joining	Clusters Joining	At Distance	Number of Members
INKA_COUNT	OLIVE_COUNT	0.034	2
MAYOLICA_COUNT	SHERD_DEN	0.100	2
MAYOLICA_COUNT	LOCAL_COUNT	0.148	3
MERCURY_POT_COUNT	COLONIAL_COUNT	0.187	2
PLASTER	NICHE_COUNT	0.223	2
OLIVE_JAR	MAYOLICA_COUNT	0.368	4
HOUSE_RANK	SERVING_PERC	0.409	2
STORAGE_PERC	MERCURY_POT_COUNT	0.426	3
MAYOLICA	OLIVE_JAR	0.435	5
INKA_COUNT	STATUS_FOOD	0.496	3
EXOTIC	COOKING_PERC	0.542	2
LITHIC_SHERD	PLASTER	0.552	3
MAYOLICA	INKA_COUNT	0.678	8
STORAGE_PERC	MAYOLICA	0.738	11
STORAGE_PERC	TOOLS	0.766	12
BONES_SHERDS	LITHIC_SHERD	0.793	4
STORAGE_PERC	BONES_SHERDS	0.888	16
STORAGE_PERC	EXOTIC	0.955	18
STORAGE_PERC	HOUSE_RANK	1.223	20

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